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Recent Bascule Bridges of Canadian Design and Construction

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and
H. W. Buzzell, A.M.E.I.C., Structural Designer,
Dominion Bridge Company Limited, Montreal.

Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY.—After mentioning the characteristics of the three principal kinds of bascule bridges, the paper describes three recent bridges of the simple trunnion type, giving the reasons leading to the particular arrangements adopted in each case, as regards the structure itself and the operating machinery. The paper indicates the manner in which the shop equipment, available transportation facilities, and local conditions at the site had to be considered in each case in deciding on the type of construction, general design, and methods to be employed in fabrication and erection.

Bascule bridges had their origin in the mediæval drawbridges which were used to span the moats surrounding military strongholds. As these, and the earliest types of bascule bridges, were not counterweighted they could only span narrow openings. With the advent of the timber truss it became for the first time possible to bridge navigable steams of some size.

The modern era of bascule bridge building may be said to have started with the construction of the London Tower Bridge, completed in 1894. Since then the bascule type has been developed rapidly and many sub-types have been invented which vary considerably in design. The vast majority, however, may be grouped into three classes:

1. The simple trunnion.
2. The rolling lift such as the Scherzer or Rall.
3. The multiple trunnion such as the Strauss or Brown.

A bascule bridge of any type may be built with either a single leaf or two leaves meeting at the centre of the opening. The single leaf bridge has the rigidity of a simple span and is, therefore, preferable, especially for railway traffic.

The simple trunnion type of bascule is one of the oldest, is the least complicated, and having a minimum of moving parts lends itself admirably to aesthetic treatment. It is essentially a see-saw rotating on fixed horizontal trunnions which turn in journal bearings supported on a pier. The fact that there are only two trunnions per leaf greatly reduces the difficulties of lining up the span during erection and also the amount of maintenance during its life. The London Tower Bridge was among the first notable bridges of this type and is still giving satisfactory service after forty years of operation. It is a double leaf structure providing a clear waterway of 200 feet and carries a 32-foot roadway and 8-foot 6-inch sidewalks.

The Scherzer type of rolling bascule has been used extensively for the past forty years and several bridges of this type span the new Welland canal. It is particularly adapted to locations where the counterweight must be kept above the roadway, but has no advantages over the simple trunnion type when the counterweight may be located under the floor.

The design of the supporting pier is complicated, particularly if rock or other good bearing strata is not found at a reasonable depth, due to the fact that the reaction from the span moves across the pier as the span opens and closes.

The design and fabrication of the track and segmental girders also present difficulties. The large load concentrations necessitate the use of very heavy metal and cumbersome details. The segmental girders particularly are costly and difficult to fabricate, taxing the facilities of the most modern fabricating plant.

The multiple trunnion type of bascule has also been extensively used. It can be built with the counterweight either above or below the roadway. It has no advantages over the simple trunnion type when the counterweight can be located below the roadway. The multiplicity of trunnions and their bearings in this type of bascule is its great disadvantage. They add greatly to the cost of fabrication and erection and also to the cost of maintenance and operation.

The three bridges dealt with in this paper are of the simple trunnion type and are located as follows:

1. Across the Red river at Norwood street, Winnipeg, Man.
2. Across the York river at Gaspé, P.Q.
3. Across the Richelieu river at Sorel, P.Q.

A general description will be given of the design, fabrication and erection of each bridge with special emphasis on those points which are peculiar to bascule bridges.

General Description

Norwood Street bridge consists of four 106-foot fixed deck plate girder spans and a single leaf deck plate girder bascule span across the navigable channel, providing an 80-foot clear waterway. The bridge carries a 50-foot roadway with two street car tracks in the centre and with an

8-foot sidewalk on each side. The bridge was built for the cities of Winnipeg and St. Boniface. Its design and construction were supervised by a board of engineers appointed by the provincial and civic governments, consisting of A. J. Meindl representing the city of St. Boniface; W. P. Brereton, M.E.I.C., representing the city of Winnipeg; and A. J. Taunton, A.M.E.I.C., representing the province of Manitoba. A plan and elevation of the bridge is shown in Fig. 1.

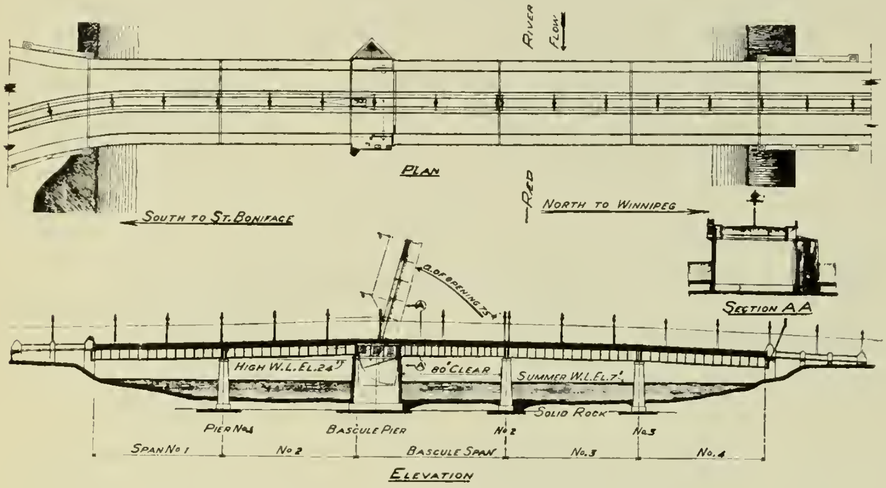

Fig. 1—Plan and Elevation of Norwood Street Bridge.

Gaspé bridge consists of five spans, four through-truss fixed spans and a double leaf deck plate girder bascule span across the navigable channel, giving a clear waterway of 90 feet. The bridge carries an 18-foot roadway with a sidewalk 4 feet 6 inches wide on one side. The owners of the bridge is La Compagnie du Pont de Gaspé Limitée, who hold a provincial franchise. The consulting engineers for the owners were Messrs. Baulne and Leonard, of Montreal. The design and details were also subject to the approval of Ivan Vallée, A.M.E.I.C., chief engineer of the Department of Public Works and Labour (Quebec). This bridge is now known as "Pont Monseigneur Ross." A plan and elevation of the bridge is shown in Fig. 2.

Sorel bridge consists of a double leaf bascule span of half-through truss construction, two steel deck truss flanking spans and reinforced concrete girder approaches. The bascule piers are 200 feet centre to centre, giving a clear channel of 165 feet. The bridge carries a 24-foot roadway with two 5-foot sidewalks. It was built for the Department of Public Works and Labour, province of Quebec, and Messrs. Monsarrat and Pratley of Montreal were appointed by the department as consulting engineers to approve the design and detail drawings. A plan and elevation of the bridge is shown in Fig. 3.

Specifications and Design

All three bridges were designed and built in accordance with the Canadian Engineering Standards Association Specifications A6-1929 and A20-1927 for Highway and Movable Bridges, respectively, as amplified by the owner's consulting engineers in each case. The design live loading varied for each bridge, the following concentrated loads being used: at Norwood street two 20-ton trucks abreast together with two 50-ton street cars on each track; at Gaspé two 15-ton trucks abreast; and at Sorel two 20-ton trucks abreast.

In addition to determining the stresses in the various members and proportioning the material to resist them, it is necessary, when designing a bridge, to carefully consider the shipping, transportation and field requirements to obtain a structure that can be fabricated, shipped and erected with the available equipment. It has also to be kept in mind that a movable bridge is a machine which must operate satisfactorily under widely varying weather conditions, and finally, but not least important, the outline must be such as to give the bridge the most pleasing appearance.

At Norwood a deck structure was adopted as it is the most pleasing type as viewed from the roadway and by using plate girders for all the spans a satisfactory outline was obtained. The approach to the bridge passes under the Canadian National Railway tracks. Due to this fact the distance between the crown of the roadway on the bascule span and high water was not sufficient to keep the counterweight clear of the water with the bridge open. To overcome this difficulty the bascule pier was built in the form of a watertight box into which the counterweight

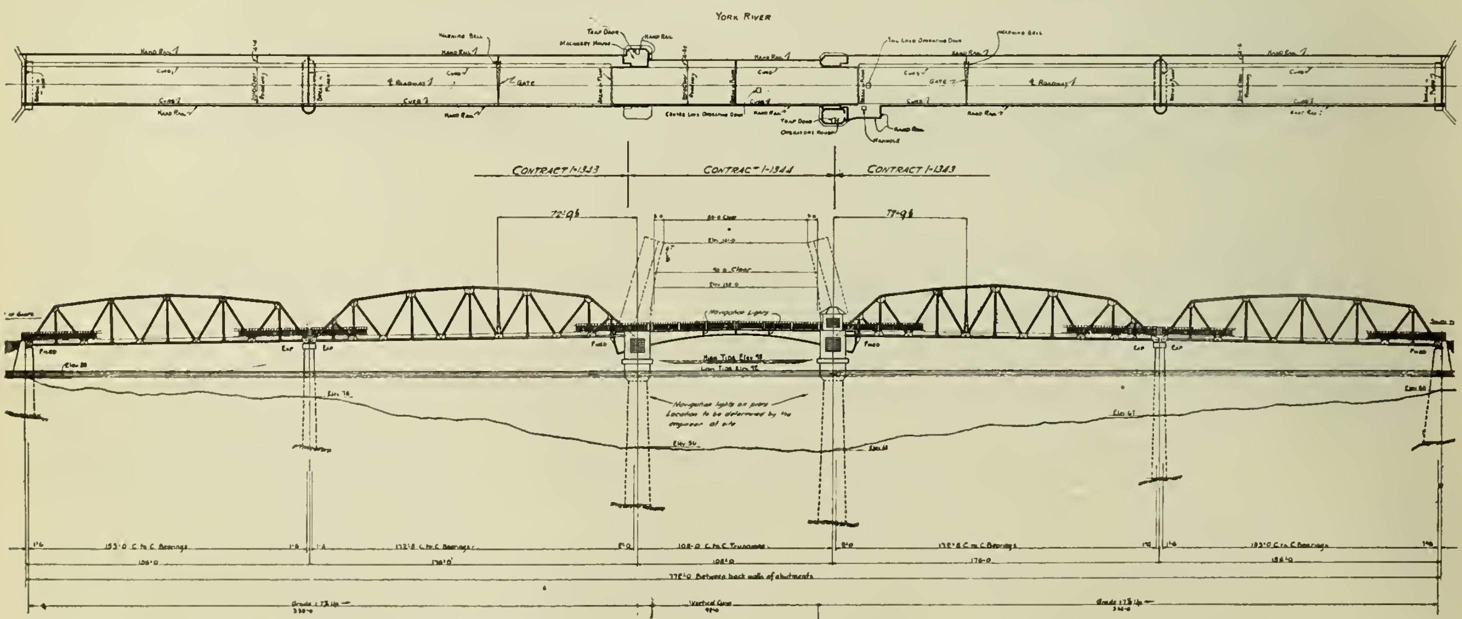

Fig. 2—Plan and Elevation of Gaspé Bridge.

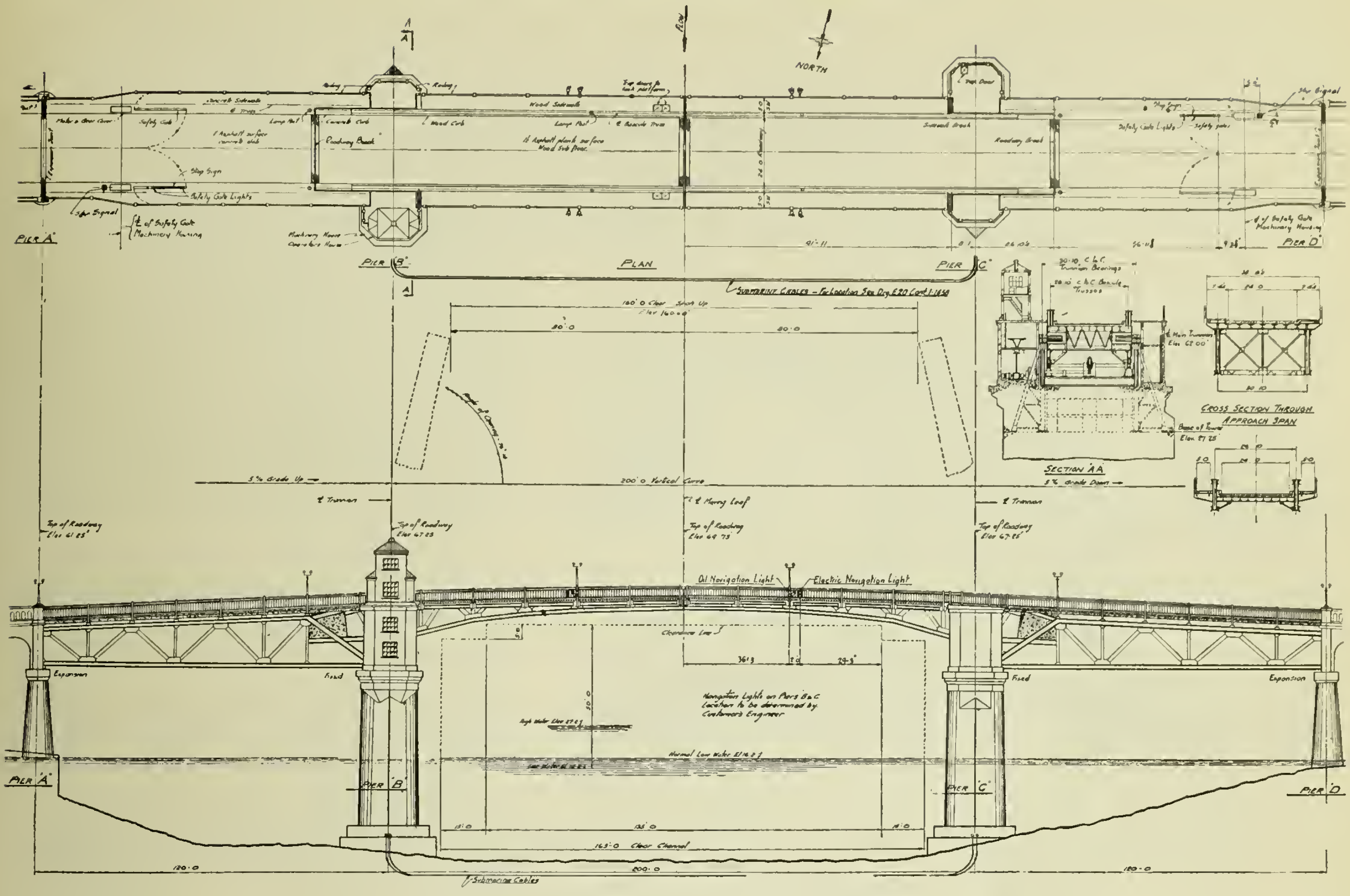

Fig. 3—Plan and Elevation of Sorel Bridge.

would sink and which would also house the operating machinery. This pier was given an architectural treatment which greatly enhanced the appearance of the bridge.

At Gaspé, due to foundation conditions, through trusses were most economical for the approach spans. Deck plate girders with a curved bottom chord were used for the bascule leaves. The counterweights are not enclosed in a pit as they normally swing clear of the water; however, they do not detract from the appearance of the bridge as they are largely hidden by the piers.

At Sorel, the approach spans are deck trusses, while the bascule leaves are half-through trusses with curved top and bottom chords. Deck trusses for the bascule leaves would have been more desirable from an æsthetic point of view, but could not be used due to the limited space between the navigation clearance line with the span down and the crown of roadway. The counterweights are in the open but are concealed for the most part by the piers and approach trusses.

The arrangement of the steel framing is shown in Figs. 4, 5 and 6 for Norwood, Gaspé and Sorel, respectively. The deck in all cases was creosoted wood protected by an asphalt plank wearing surface.

The design of the floor steel for a bascule span is identical with that of an ordinary highway span, except that provision must be made for transferring the weight of the floor to the trunnions when the bridge is in the open position. This is done by means of an auxiliary truss spanning between the main trusses in the plane of the laterals.

The stress calculations for the design of the main girders or trusses in this type of bascule are not involved. The dead weight of each bascule leaf must be balanced in all positions about the trunnions. This condition is attained by so locating the counterweight that the centres of gravity of the forward and rear arms of the leaf are on a straight line passing through the axis of rotation. The dead load stresses are, therefore, figured as for a simple cantilever, but the maximum stresses do not always occur with the leaf in the closed position. It is necessary to investigate the stresses for several positions of the leaf.

The live load stresses, in a single leaf bridge, are figured as for a simple span with a length equal to the distance from the trunnion to the rest pier. In a double leaf bridge the stresses in each leaf due to live loads symmetrically placed about the junction of the leaves are figured as for a simple cantilever supported at the trunnion, and with the uplift at the tail of the leaf resisted by the adjacent approach span. For live loads which are unsymmetrically placed about the junction of the leaves, the stresses are figured as for a cantilever with an elastic prop at its outer end. This is due to the fact that shear locks are provided between the ends of the two leaves to prevent unequal deflections.

Wind stresses with the bridge open are figured as for a cantilever span. The two cases of longitudinal and transverse wind must both be investigated. The wind stresses in a single-leaf span when closed are similar to those in a simple span, while in a double-leaf span each leaf is treated as a cantilever.

The maximum resultant stresses are obtained for different positions of the span by summing the co-existing stresses. The allowable unit stresses to be used in proportioning the truss members to resist the various combinations of stresses are laid down in the specification.

The design of the trunnion supports usually requires more ingenuity than the remainder of the bridge as it is difficult to place them so that they will clear the bascule leaf as it rotates. Two different methods of supporting the trunnions are used in these bridges.

At Norwood, each trunnion is carried by two bearings, one on each side of the girder web. At Gaspé and Sorel the trunnions project as cantilevers from the moving leaf, and each trunnion is supported by a single bearing.

At Norwood, the outer bearings are carried on columns which extend to the floor of the counterweight pit and which are braced laterally in two directions to its walls as shown in Fig. 7. The inner bearings are carried by trusses which span the counterweight pit and rest on its front and rear walls. The bottom flanges of the trusses are shaped to clear the counterweight when the span is closed, and the top flanges conform to the grade of the roadway because these trusses also carry the roadway framing over the counterweight pit. This allows the roadway break to be located ahead of the trunnion and obviates a gap in the floor when the bridge is open. Figure 8 shows one of these trusses in position. As can be seen, the trunnion is located about midway between the chords of the truss. To provide a seat for the trunnion bearing and to take care of the local bending stresses the end section of each truss is made into a double web plate girder. Openings are provided in these webs to clear the bearing and its cap. The bearing is seated on angle stiffeners riveted to these webs.

The load is transmitted directly to the trunnion from the main girder web, which is reinforced to take care of the heavy stress concentrations at that point. A cast steel sleeve is used to increase the bearing length on the trunnion. This sleeve is a press fit in the reinforced girder web and is securely riveted to it. The trunnion is in turn a press fit in the sleeve and keyed to it to prevent rotation.

At Gaspé and Sorel the supports for the trunnion bearings are braced towers located just outside the main girders. The framing of these towers is not the same for the two bridges because of differences in the size and shape of the bascule piers. Although the towers are finally embedded for about half their height in the mass concrete of the pier in both cases, the steel is designed to carry all the vertical and horizontal loads transmitted to them during the operation of the bridge. The arrangement of the trunnions, trunnion bearings and towers are shown in Figs. 5 and 6 for Gaspé and Sorel, respectively.

It is more difficult to connect the trunnions to the span with this arrangement than when two bearings support each trunnion. In the latter case, no bending strength is required in the connection, while in the former the connections must have sufficient bending strength to make the trunnions and trunnion strut act as a simple beam supported at its ends on the trunnion bearings and carrying the load from the leaf applied in the planes of the trusses.

At Gaspé, a box strut located symmetrically about the axis of the trunnions is framed between the main girders. Vertical diaphragms are provided in this strut, one about 3 feet from each girder. The main girder webs and these diaphragms provide the loading points for the trunnions, the webs being reinforced to give sufficient bearing area.

At Sorel a similar trunnion strut is used, but due to the greater loads to be carried and to the fact that the main trusses have two webs, certain complications arose not en-

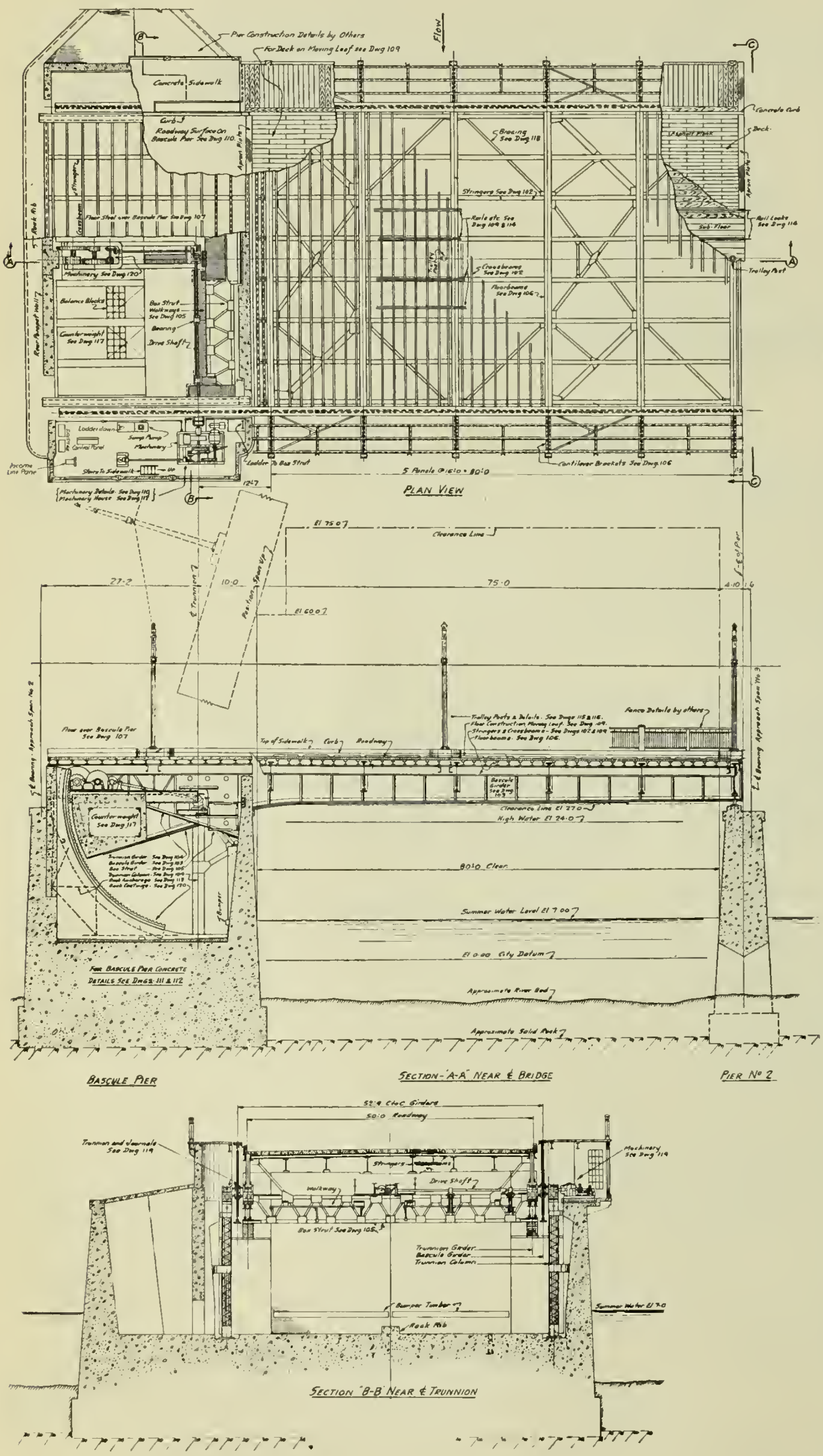

Fig. 4—Steel Framing Plan, Norwood.

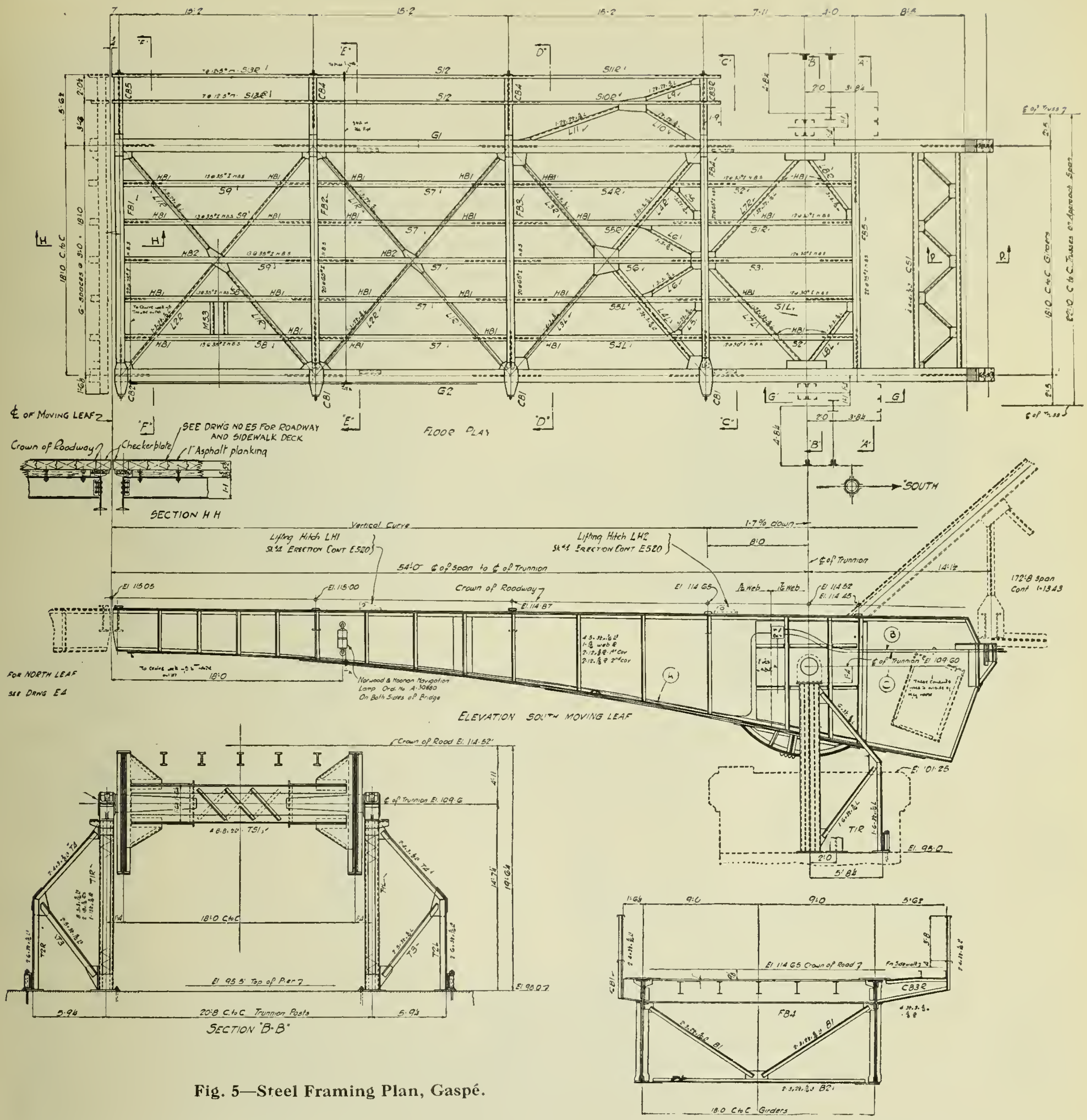

Fig. 5—Steel Framing Plan, Gaspé.

countered at Gaspé. To allow the trunnion strut to be connected to the trusses, web plates are used instead of web members for a distance of about 5 feet on either side of the trunnion.

In the first sketches made of the detail at this point, the trunnion strut was connected by angles to the inner web plates of each truss. Diaphragms were provided between the two webs of the truss in line with the end connections of the strut to distribute the load between the webs. Diaphragms were also provided in the strut about 5 feet from the centre line of each truss to carry the inner end of the trunnion. The trunnion was thus loaded by both webs of the truss. Investigation of the distribution of the load on the trunnion, considering only its deflection due to bending and shear, showed that the outer webs of the trusses delivered the greater part of the load. The distribution thus determined was not exact as it would be modified by the elastic deformation of the web plates themselves and it was impossible to evaluate this with any degree of accuracy.

Further investigation led to the development of another detail which was finally adopted. In this design the inner web plate of each truss is cut out to clear the trunnion strut which extends through and connects directly to the outer webs. Connection angles are provided on the four sides of the strut to connect to the inner webs of the trusses. The diaphragms are placed at about the same points in the struts as in the earlier design. With this

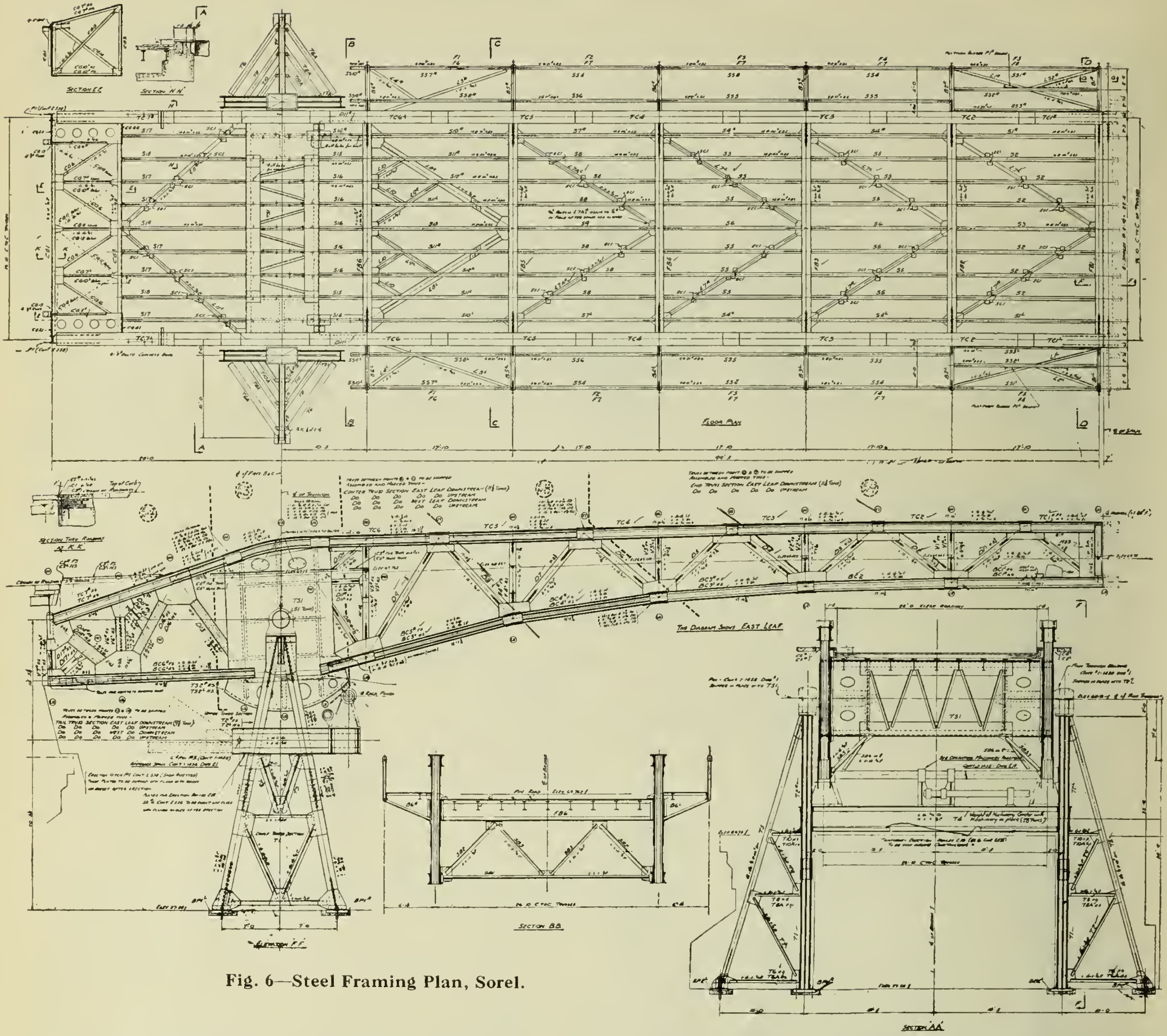

Fig. 6—Steel Framing Plan, Sorel.

detail each trunnion is only loaded at two points, i.e., at the outer truss web and at the diaphragm. This gives a satisfactory and determinate distribution of the load on the trunnion, which is a theoretical advantage.

The elimination of the inner web plate in the area of the trunnion strut was also a great advantage from the fabrication point of view. It made a much simpler and a much better detail to fabricate. In the original detail the necessary diaphragms between the two webs in this area left very cramped spaces in which to do the final assembly and riveting.

To avoid excessive wear on the trunnion bearing and to ensure easy operation of the bridge, it is essential that the trunnions have a uniform bearing on their journals. To ensure this, it was decided to limit the slope of the trunnions to .010 inches in the length of its bearing under maximum load conditions, neglecting the relief due to compressibility of the bearings themselves. This was done by increasing the size of the trunnion and trunnion strut over that required for the figured stresses. This increase in size of the strut is such that the figured stress in it is only about 4,000 pounds per square inch.

The necessity of maintaining a reasonable slope of the trunnion in its bearing is one of the limiting features of this arrangement of trunnion supports. As the weight of the leaf increases it is more and more difficult to design a stiff enough trunnion strut. There is an alternative, i.e., to tilt the trunnion bearing to the theoretical slope of the trunnion. This would require very accurate workmanship in shop and field, and as far as the authors know this method has never been used.

Mechanical Equipment

All three bridges are electrically operated with provision for handpower operation in case of electric power failure. In each case the torque is applied to the leaf through racks and pinions. At Norwood the pinion is on the leaf and rotates with it, while at Gaspé and Sorel the pinions are fixed and the racks are attached to the moving leaves. The machinery was designed so that it could be shop assembled in units on suitable structural frames. These were, where possible, directly connected to the bridge frame to facilitate the lining up of the mechanical equipment in the field.

All trunnions and large shafts were forged. All castings were steel and all gear teeth, including those on the racks, were cut. On similar structures in the future, due to the rapid strides that have been made in welding technique, castings would be largely replaced by welded units.

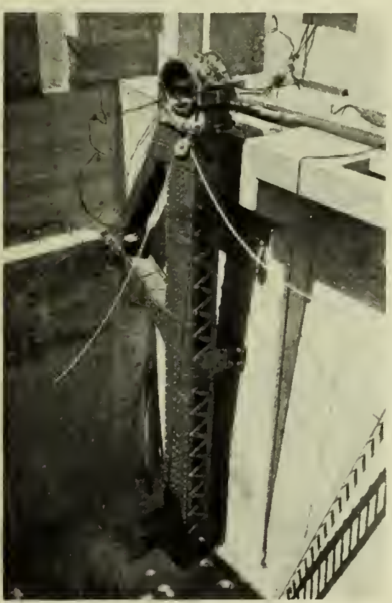

Fig. 7—Trunnion Bearing Post, Norwood.

Figure 4 shows the arrangement of the operating machinery at Norwood. A single pinion and rack on the centre line of the bridge operates the span. The motor, brake and gear reduction, located in the machinery house, were assembled in the shop on a structural base and were shipped as a unit. The operating pinion with its gear train was also assembled and shipped as a unit. This unit was connected in the field to the counterweight truss. The connecting shafts with their bevel gears were lined up in the field. The rack was assembled in the shop to a structural frame which was embedded in the back wall of the bascule pier. This frame was provided with levelling screws and anchors so that it could be brought to and held in its proper position in relation to the trunnion while concrete was poured around it.

Auxiliary mechanical equipment consists of: hand operated span locks of the sliding bar type; two air buffers attached to the toe of the bascule; and a centering device to centre the span when seating and to take the wind reaction with the span down. As it was not expected that the bridge would be frequently operated, interlocks between the span locks and the operating machinery, and highway gates, were omitted.

Fig. 8—Trunnion Truss at Norwood.

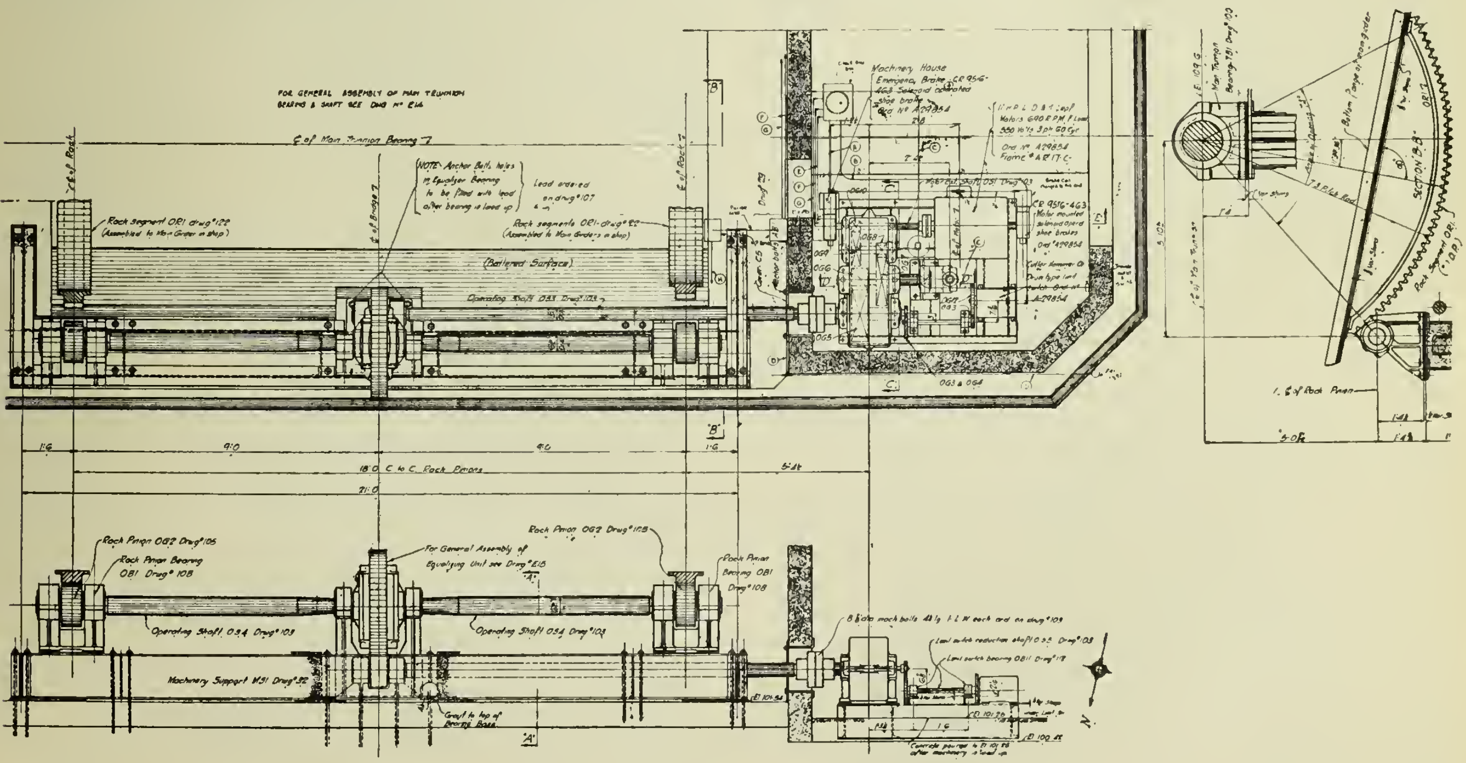

Fig. 9—Operating Machinery at Gaspé.

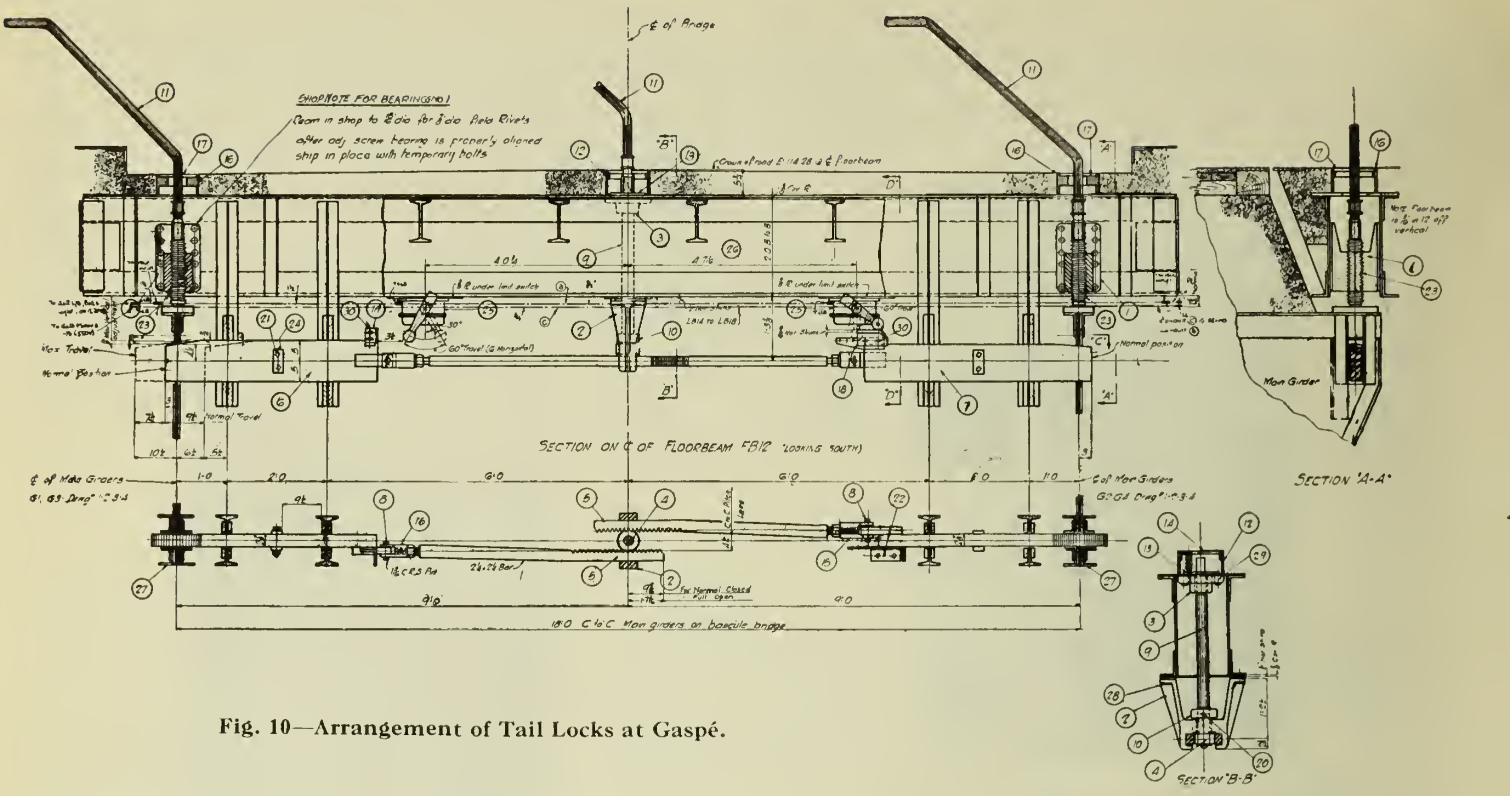

Fig. 10—Arrangement of Tail Locks at Gaspé.

Figure 9 shows the arrangement of the operating machinery at Gaspé. Each leaf is operated by two pinions and racks. The racks are attached to the bottom flanges of the girders over the piers. The operating machinery was assembled in the shop into two units: the first, consisting of the motor, brake and gear reduction unit; the second, of the equalizer unit, the main operating shafts with their bearings and the main pinions. The first unit is located in the machinery house and is connected to the second by an operating shaft which carries the pinion of the equalizing unit. The second unit was assembled on a box girder which was designed to be anchored to, and built into the pier after the main pinions were lined up.

The auxiliary mechanical equipment consists of manually operated shear-locks at the junction of the leaves, manually operated tail-locks at one end of one leaf to resist the reaction from live load on the portions of the bascule roadway behind the trunnions, and motor operated highway gates of the ordinary railroad crossing type. Figure 10 shows the arrangement of the tail-locks. Electrical interlocks are provided between the span locks, highway gates and operating machinery, to ensure that all operations are carried out in the proper sequence.

Figure 11 shows the arrangement of the operating machinery at Sorel. The arrangement of the operating pinions and racks is similar to that at Gaspé. The machinery was assembled in two units as at Gaspé, but the box girder carrying the equalizer, etc., was framed between the towers carrying the main trunnions. This allowed the main pinions to be lined up from the trunnion bearings in the shop and greatly reduced the time required for lining up in the field. This girder was also anchored to the pier and concreted in.

The auxiliary mechanical equipment consists of motor driven shear locks at the junction of the leaves; motor driven tail-locks; air buffers; and motor driven highway gates of the horizontal swinging type. Figure 12 shows the arrangement of the tail-locks and air buffers. Figure 13 shows the shear locks at the junction of the leaves. These are designed to line up the ends of the two leaves vertically if unequal deflections occur due to temperature differences. Air buffers were used as they were considered essential with a span of this weight to allow of closing it without imposing an excessive impact on the approach spans. They were not provided at Gaspé, as the mass of the moving leaf was relatively small.

Figure 14 shows the arrangement of the highway gates. This design is original and patents have been applied for. The gate, which is mounted on a vertical trunnion at the curb, is built of structural steel and is substantial enough to withstand, without damage, a moderate blow from a car. The trunnion, carried in a bearing attached to the floor steel, has a bullwheel rigidly attached to it underneath the floor slab. The gate is operated by means of a rope drive on this bullwheel. The operating mechanism, consisting of a motor, gear train and operating drum, is housed in a steel cabinet on the sidewalk. The operating rope between the drum and the bullwheel passes under a sheave mounted on a vertically guided counterweight which during normal operation of the gate rests on a bracket and has no function to perform. If, however, the gate is struck by a vehicle when in the closed position it swings open under the blow and the counterweight is lifted from its support, thus protecting the operating machinery from damage. As the vehicle backs away from the gate the counterweight brings it back to the closed position and the gate is immediately ready for normal operation.

Electrical interlocks are provided between the operating machinery, span locks and highway gates. A mechanical interlock is also provided between the tail-locks and highway gates.

Due to the modern practice of using cut teeth for all gears and the high degree of accuracy attained by modern shop methods, the question arises whether it is necessary to provide an equalizing unit between the main pinions as was done in these bridges. From an examination of the units at Sorel, it appears that no movement whatever has occurred in them. Their omission would result in considerable economy and the authors feel it is a question well worth the consideration of all those interested in movable bridge construction.

Electrical Equipment

At all three bridges the main power supply is 550 volts, 3-phase, 60-cycle; 110-volt power is used for the lighting and the control circuits in all cases.

At Norwood a 60-h.p. at 720 r.p.m. slip ring, wound rotor induction motor is used for operating the bascule span. It is capable of opening the bridge in three minutes under normal conditions, or six minutes with ice load. A service and an emergency brake, both thrustor operated, are provided. The service brake is mounted on the motor shaft, while the emergency brake is mounted on one of the operating shafts. The bridge is operated from a control desk at the sidewalk level. Control is through a semi-magnetic control panel located in the machinery room. A cam type rotating limit switch is mounted in the machinery house which cuts off the power and operates the various indicating lights. Two rotating cam type limit switches are also connected to the end locks. They are mounted in series and are closed only when the locks are fully withdrawn. A plunger type limit switch is attached to the end of the span and operates the "fully closed" indicating light on the operating desk.

At Gaspé, each leaf is operated by an 11-h.p. at 720 r.p.m. wound rotor motor, which can open it in one and a half minutes under normal conditions or three minutes with ice load. The highway gates are operated by four ¾-h.p. at 1,200 r.p.m. squirrel cage motors. Solenoid brakes are mounted on all motor shafts. The main power supply is obtained from a gasoline driven generator located on one floor of the machinery house. The gasoline engine is a 130-h.p. at 1,200 r.p.m. and is connected by a V-belt drive to a 93-kv.a., 550-volt, 60-cycle, 3-phase alternator. 550-volt power, in case of failure of the gasoline engine, and 110-volt power for the lights and control system at all times, are obtained from the local supply.

The generator, control panels, and operator's desk are located over the machinery house on the main pier on the Gaspé side. Power and control circuits are carried across the channel in submarine cables. These cables are buried five feet in the bottom of the river and are brought up the piers through pipes provided when they were built. The operator's desk, on which all switches and indicating lights together with a voltmeter and ammeter are mounted, is located in a house which is at deck level and from which the operator has a clear view of the whole bridge. The main incoming line switch is also mounted in this house. On the floor immediately below the operator's house the gasoline driven generator is located. The control panels and resistors are placed in the machinery house.

At Sorel, each leaf is operated by two 20-h.p. at 720-r.p.m. wound rotor motors, which open it in two and a half minutes under normal conditions, or five minutes with ice load. The end locks and centre locks are operated by four 3-h.p. at 720-r.p.m. squirrel cage motors. The roadway gates are operated by four 1-h.p. at 900 r.p.m., five minute rated, totally enclosed motors. Solenoid brakes are provided on all motors, and in addition an emergency thrustor operated brake is provided for each leaf. All motors are controlled by semi-magnetic control equipment installed on the Sorel side of the channel. The primary and secondary leads of the far side leaf motors, end lock motors, and gate motors, together with the leads for limit switches and lights, are brought across the channel in six submarine cables located downstream from the bridge. The cables are brought up to the machinery houses through pipes placed in the piers when they were built.

To house the control panels, resistors and operator's desk a two-storey brick house was built on the downstream end of the main bascule pier immediately over the machinery house on the Sorel side. The operator's desk and incoming line switch are located in the upper storey from which the operator has a clear view of all points on the bridge. The controls for all operations are mounted on the operator's desk. They consist of two drum controllers for the

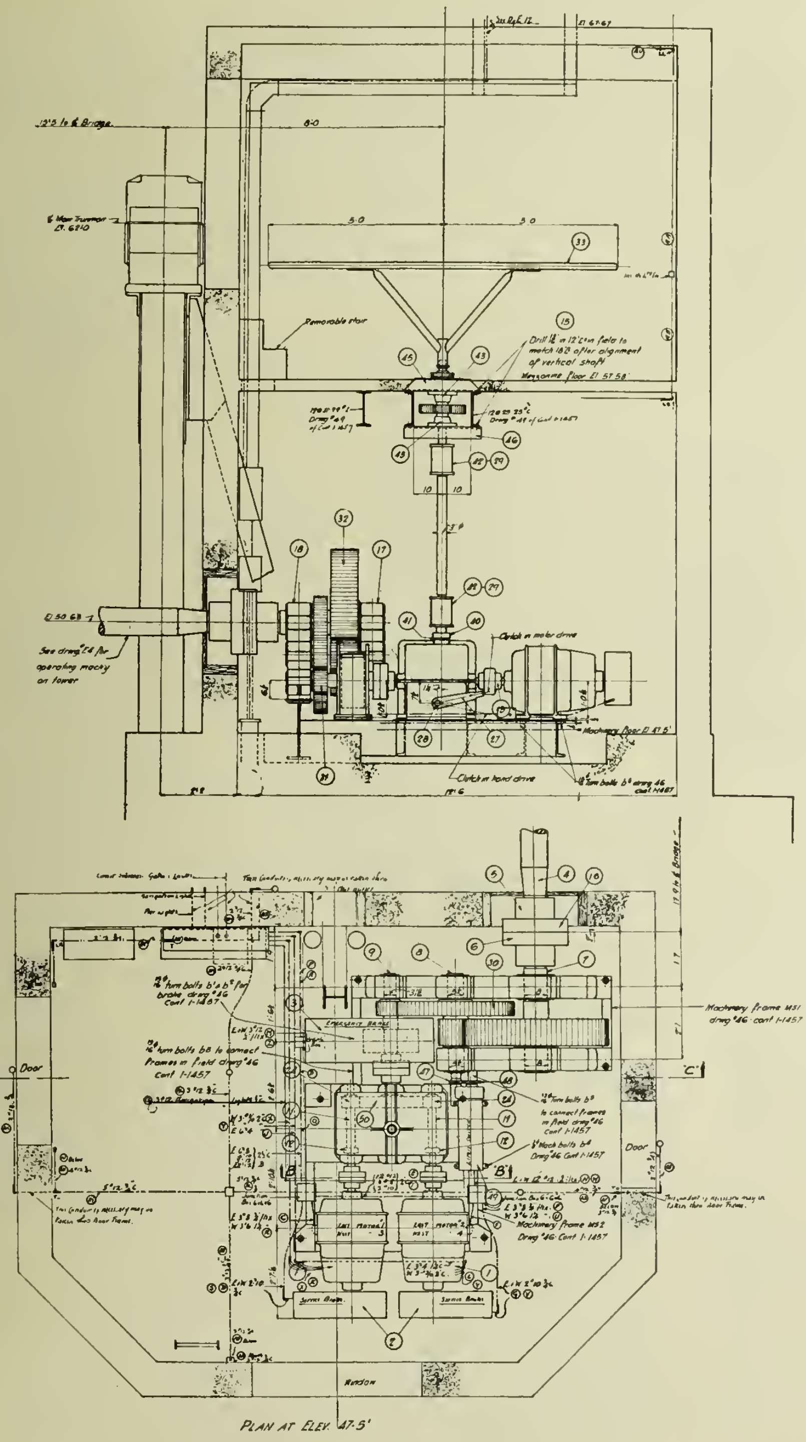

Fig. 11—Operating Machinery at Sorel.

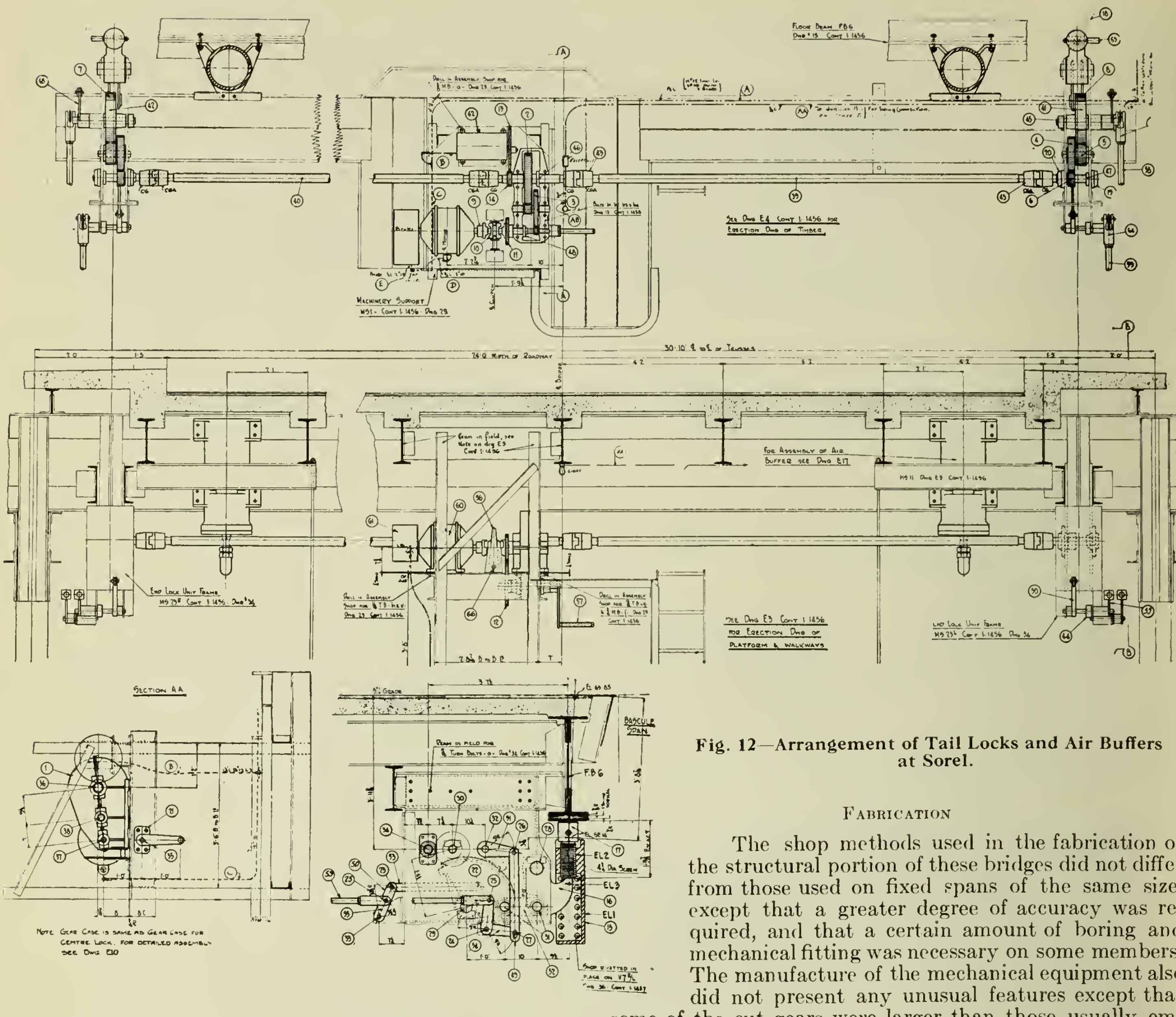

Fig. 12—Arrangement of Tail Locks and Air Buffers at Sorel.

main motors; four reversing drum switches for the end lock and centre lock motors; four reversing switches for the roadway gates; a switch for the bell circuit; eighteen indicating lights; seven tumbler switches for emergency brakes; a voltmeter; an ammeter; and two reduced torque push button stations.

The lower floor of the house contains the two control panels upon which are mounted the necessary switches, contactors, overload relays, undervoltage contactors necessary for all the motors, lighting and control circuits on the bridge. The necessary resistors are also located in this room.

Limit switches are provided on all motors, which operate lights on the operator's desk in such a way that he knows at all times the position of the bridge. Provision is also made to cut the power supply off from the main motors when the bridge is 7 degrees from both the fully closed and open positions. From that point the movement of the bridge must be completed by the operator by-passing the limit switch. When the switch is by-passed only a reduced torque is available at the motors which ensures easy closing of the bridge.

Fabrication

The shop methods used in the fabrication of the structural portion of these bridges did not differ from those used on fixed spans of the same size, except that a greater degree of accuracy was required, and that a certain amount of boring and mechanical fitting was necessary on some members. The manufacture of the mechanical equipment also did not present any unusual features except that some of the cut gears were larger than those usually employed. Shop assembly of the mechanical equipment to the structural portions of the spans was carried further than on any previous bridge. This was particularly the case at Sorel and the results obtained in the field fully justify the adoption of similar methods in the future. The erection of the mechanical equipment was expedited, and the operation of the bridge was improved.

At Norwood, the main girders were each 118 feet long, 13 feet deep at the tail end and weighed 56 tons. Ordinarily girders of this size cannot be shipped by rail in one piece, but in this case it was possible due to the short haul from the shop to the site. These girders were also heavier than the normal capacity of the shop cranes, but by careful planning both girders were fabricated and handled without undue difficulty.

The first operation in their construction was to assemble and rivet together the web and reinforcing plates forming the section of the girder around the trunnion. The 30-inch diameter hole for the trunnion sleeve was then bored in these plates after which the sleeve with the 24-inch diameter trunnion in place was assembled in position, the connecting holes reamed, and the rivets driven. The next operation was to assemble and bolt up the whole girder after which it was carefully lined up by transit and levelled so that the trunnion was at right angles to the girder web. All holes were then reamed and the rivets driven. The girders were turned into the vertical position and loaded for shipment.

At Gaspé, the main girders were assembled and riveted in the usual way without accurately locating the hole for the trunnion. The two girders of each leaf were then shop-assembled into a unit with the trunnion strut and counterweight strut in place, also sufficient floorbeams and bracing to give a rigid structure. The main connections were then reamed. The location of the holes for the trunnions in the webs of the girders, and in the trunnion strut diaphragms, was next carefully determined by means of transit and level. The leaf was dismantled and the holes bored for the trunnions on a horizontal boring mill. The two holes for each trunnion were bored in one setup on the machine as the trunnion strut was spliced at two points, with the portions containing the diaphragms shop riveted to the girders. The trunnions were next driven into position in the girders. The racks were then placed in position on the lower flange of each girder and after being centered about the trunnions were shop riveted in place. The equalizer unit and bearings for the main pinions were also shop assembled to the machinery girder and shipped in place on it. This girder was not connected to the trunnion bents so that it could not be lined up in the shop to the trunnion bearings.

The location of Sorel bridge was such that barge shipment direct from the shop to the site was most economical. This allowed the shipment of pieces of larger overall dimensions than could be sent by rail. As a result each leaf was shipped in sections, the largest of which consisted of a trunnion strut, two trunnion pins and the plated portion of two trusses adjacent to the trunnion. Each of these sections weighed 51 tons.

The various truss members were fabricated in the usual way after which each truss, except for the section at the trunnion, was assembled in the shop on the flat and carefully lined up by transit to its cambered shape. All joints were reamed and certain ones riveted before shipment. To take the place of the plated section at the trunnion during assembly, a skeleton section was built which had connection holes for adjacent members accurately located from the sections it replaced.

The plated sections at the trunnions after being completed were assembled to the ends of the trunnion struts, lined up and the connections reamed and riveted. The centres of the trunnion pin holes were then carefully located, by means of a level and a piano wire, on each of the four webs through which the trunnions passed. Each section was next placed in the boring mill and the holes bored. The bar of the boring mill was only long enough to bore the hole through the two webs at one end of the section, so that to complete the boring the piece was rotated about a vertical axis through 180 degrees. After boring was completed the holes were carefully checked for line and were found to be within a few thousandths of being in exact alignment. The trunnion pins were not finished turned until after the holes were bored so that any inaccuracies in the actual size of the holes could be compensated for in the diameter of the pins. After turning, the pins were driven into position with a heavy ram. They are held in place by keys and a nut on the inner end. The racks were next assembled in position and lined up from the trunnions.

As can be seen from Fig. 6, the trunnion towers are three-post triangular structures. They were completely assembled in the shop and shipped in one piece. A shop splice was provided in the two main legs of each tower, to permit of the shop assembly of the machinery girder on the towers, since the clearance under the available cranes was not sufficient to allow of erection of the complete towers. The two main posts with their bracing in the plane parallel to the centre line of the bridge were first assembled and riveted except for the shop splice which was reamed. The top sections of the two "A" frames for each pier were then set up with their connecting machinery girder. The trunnion bearings, equalizer unit, rack pinion bearings, operating shafts and rack pinions were next set in position and carefully lined up to their correct positions. The holes for the holding-down bolts for the units on the machinery girder were reamed and the bolts placed. It was originally intended also to ream the holes and place the holding-down bolts for the trunnion bearings, but it was later decided to leave them to be reamed in the field in case any twist should occur in the bents due to handling or riveting. The trunnion bearings were, therefore, held in place for shipment by tack welding. The machinery girder was removed from the tower with the machinery in place and was shipped in that condition. The towers were then assembled, riveted up, and shipped in one piece. Figure 15 shows the assembly of the trunnion bents with the machinery girders in the shop.

To facilitate the work in the field, it is essential that accurate centre lines be established in the shop on those

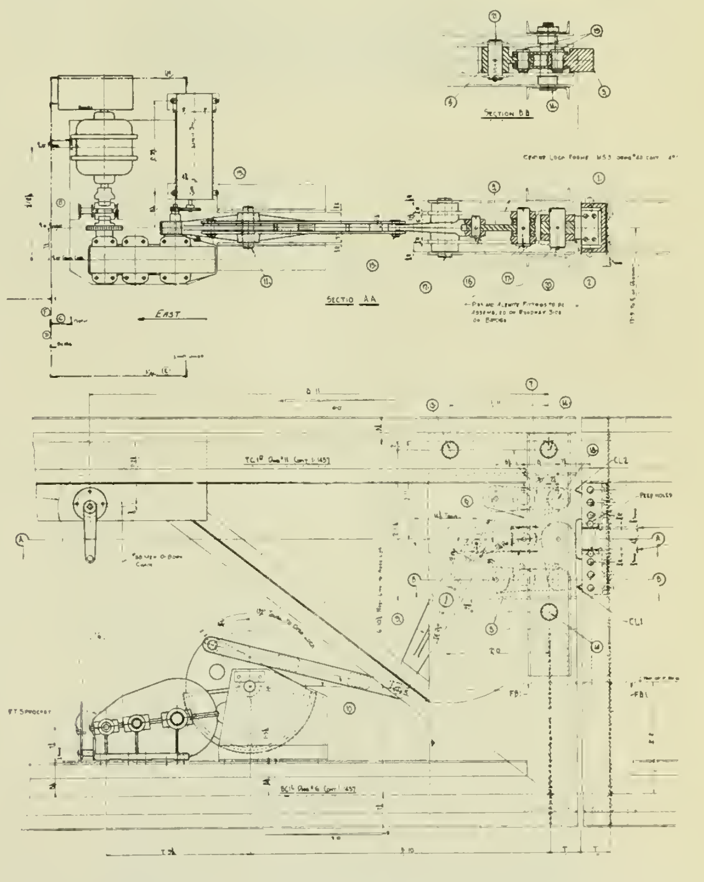

Fig. 13—Arrangement of Shear Locks at Junction of Leaves at Sorel.

portions of the structure which are first placed and on the accurate location of which depends the alignment of the whole structure. To do this, it is necessary to plan the erection procedure in advance so that the centre lines established in the shop are in suitable locations for use in the field. At Sorel, the erection procedure was established before the detail drawings were issued to the shop and the latter carried full instructions as to the points where centre lines were to be established on the trunnion bents and machinery girders. These lines were carefully laid out and clearly marked on the steel while the trunnion bents were assembled.

The remainder of the fabrication of the bridge did not present any unusual features.

Erection

The method of erection adopted for any bridge is not standard for all bridges of that type. It varies greatly due to differences in conditions at the site, the weight and size of pieces to be handled, and the equipment the contractor has available. Since no standard method can be laid down, it is essential for economical erection that each job be carefully planned in the office before erection commences and that sufficient drawings be prepared to show the arrangement of the equipment to be used and outline the sequence of, at least, the major operations.

The erection of these three bridges present examples of several of the methods, and of some of the different kinds of equipment that are used in bridge erection.

Norwood Street

At Norwood conditions at the site favoured the use of locomotive cranes, as a railroad line was situated close to the south end of the bridge. Also, the cranes were available at Winnipeg, and the bridge as designed was strong enough to carry them. As locomotive cranes can only handle heavy loads at a short radius, it was necessary to provide a track which would bring them close to their

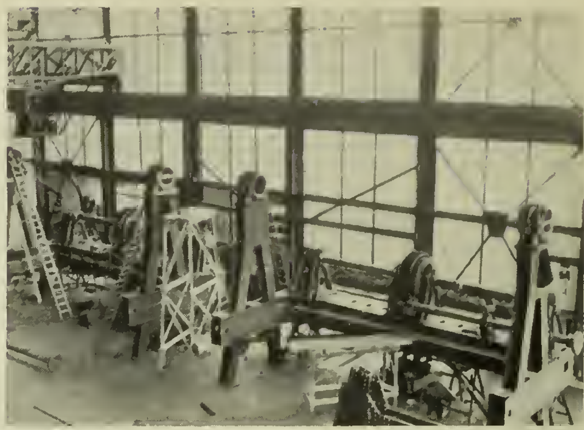

Fig. 15—Assembly of Machinery Girder and Bents.

loads. A pile trestle carrying a standard gauge track was, therefore, built across the gap on the centre line of the bridge. The bridge stringers were used to span between the pile bents and were placed at their correct elevation so that they could be connected to the floorbeams as the latter were placed, and thus release the piles for re-use. Sufficient piles were supplied for a trestle under three spans.

The first pieces erected on the bascule span were the

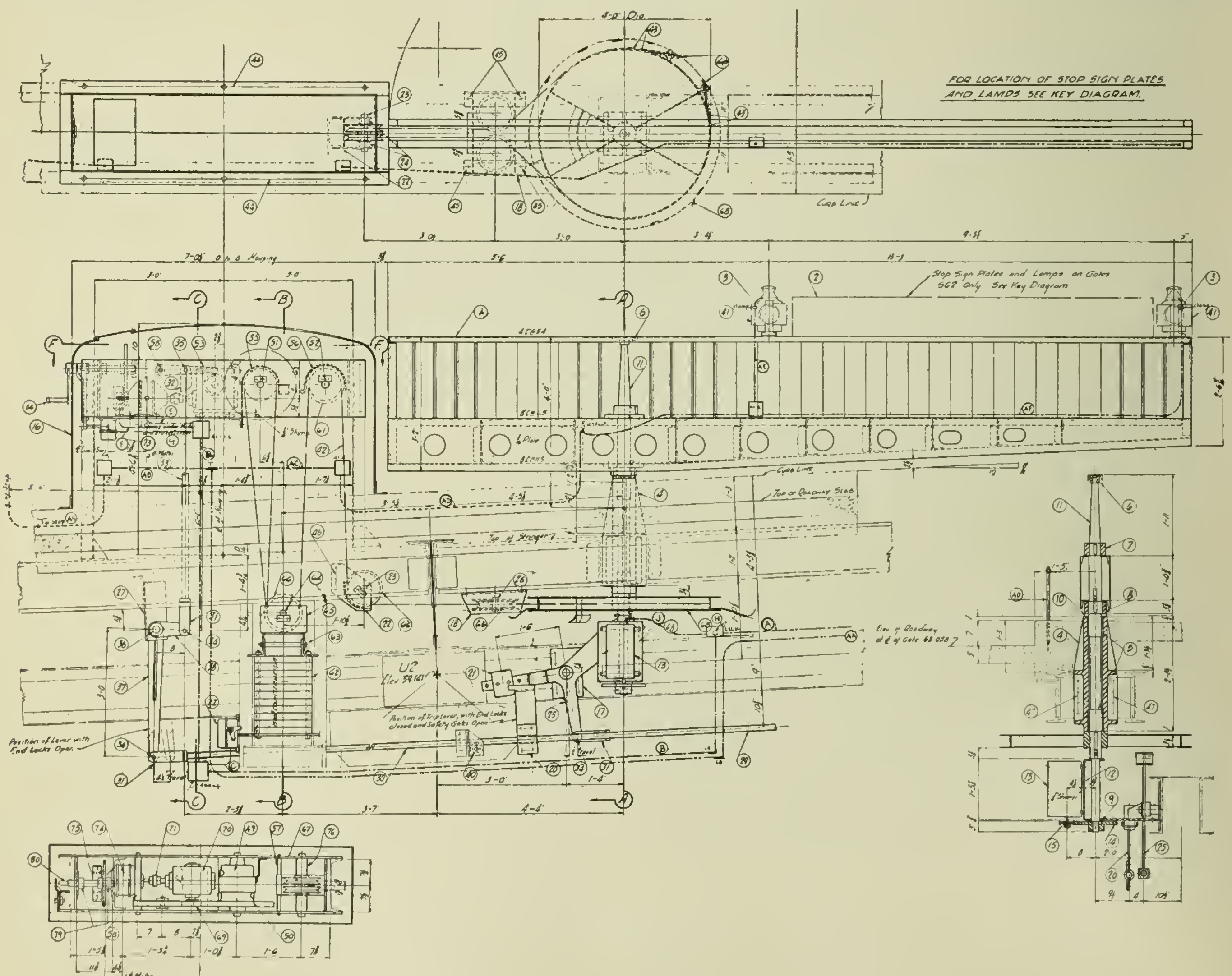

Fig. 14—Arrangement of Highway Gates at Sorel.

trunnion posts. They were set in position and shimmed so that the trunnion bearings were in perfect alignment. Figure 7 shows the downstream post in final position.

The main girders were next erected. Each girder was run out on two flat-cars between two locomotive cranes, as shown in Fig. 16. When the girder reached its proper position, it was lifted by the two cranes and landed on the piers about 8 feet 6 inches from the centre line of the bridge. The flat cars were then removed, and the track on the approach span next to the tail of the girder was swung out so that the crane could lift that end of the girder into its final position. The toe end was moved out on rollers. The tail end was lowered into the slot in the bascule pier wall until it rested on a temporary timber bent erected in the counterweight pit. This held the girder slightly above its final elevation. The trunnion trusses with the inside trunnion bearings were next placed.

The next operation was the lining up of the two main trunnions and the connecting up of the counterweight and bracing to the main girders. A piano wire was stretched through the holes provided in the trunnions and was used to line them up. The girders were jacked to their correct position longitudinally and laterally, and to an elevation such that the two trunnion pins were $\frac{1}{4}$ inch above their theoretical position. The counterweight strut was then erected and connected to the girders, care being taken to maintain the girders in position. The bearings on the trunnion posts were now shimmed up until there was $\frac{1}{8}$ inch clearance between the bearings and the trunnions, while the inside bearings were brought up to within $\frac{1}{4}$ inch of them. The outer bearings were left $\frac{1}{8}$ inch high to allow for the fact that the posts would deform more than the trusses under the load of the span. The strut connecting the trunnion trusses was next connected up and the main girders were jacked down until the full load came on the trunnion bearings. The alignment of the trunnions was again carefully checked, due allowance being made for the deformation of the columns which would occur when the full dead load of the span was in place.

The rack, shipped in one piece assembled on a structural frame, was next placed in position and centered with reference to the trunnions. Anchors and adjusting screws held

Fig. 16—Erection of Bascule Girder at Norwood.

it rigidly in position while the frame was concreted in. Dowels had been left projecting from the pier to provide a bond between this concrete and the pier.

The locomotive cranes completed the erection of the floor steel, machinery units and flooring, while at the same time the forms were built for the counterweight and the concrete poured. It was possible to do all this work with the span in the closed position, which greatly simplified all the erection problems.

The bridge was completed and formally opened on November 19th, 1931. Figure 17 shows the finished bridge.

Gaspé

At Gaspé, some of the factors governing the method of erection to be adopted were:—

(*a*) The river had a maximum depth of 50 feet and the bottom was covered with a thick soft layer of mud which gave little support for piles.

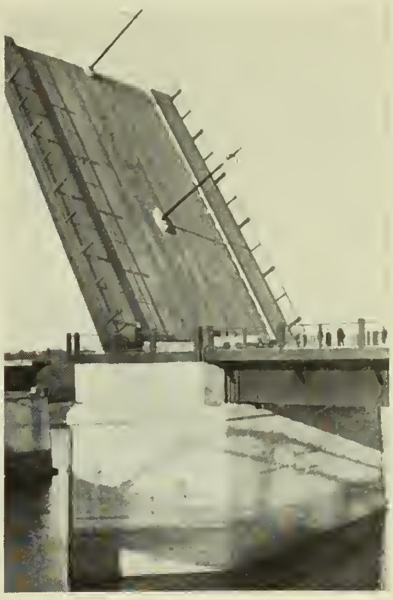

Fig. 17—Completed Norwood Street Bridge.

(*b*) The weight of the heaviest piece to be handled was only 14 tons.

(*c*) The span as designed could only carry relatively light erection equipment.

(*d*) Erection had to proceed from both ends as the bascule had to be erected in the open position.

(*e*) All material coming in by rail or boat arrived on the south shore of the river.

After considering all the factors involved, it was decided to erect the fixed spans one at a time on falsework at a suitable location and then float them into position on

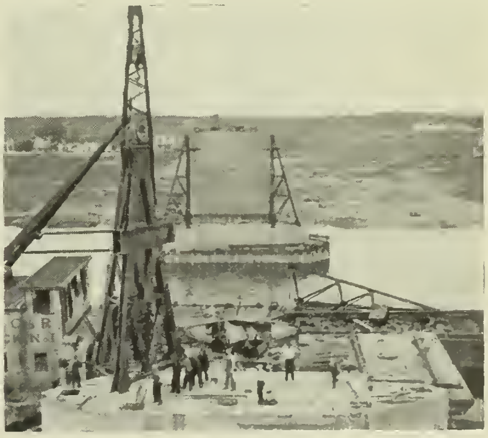

Fig. 18—Placing Trunnion Towers at Sorel.

scows, using the tide to lift the spans off the falsework onto the scows and again to lower them into position on the piers. The steel was erected on the falsework with a light traveller which consisted of a 5-ton stiffleg traveller mounted on a wooden base, together with the hoisting engine. The falsework was actually located between the abutment and pier No. 1, and the fixed spans were erected in order starting from the opposite end, so that the last span was erected in its proper location.

The trunnion towers were the first portion of the bascule span to be erected. As soon as the first bascule pier was completed to the elevation of their base, the towers were placed by a floating derrick. The piers had been bush hammered to exact elevation over the area required for the base plates. The towers were then lined up and anchored. The pier was next completed up to the elevation of the machinery house floor, after which the trunnion bearings were placed in position, lined up, and bolted to the trunnion towers. Shims were required to bring the bearings to correct elevation and the holes also had to be reamed for the connecting bolts. This gave a perfectly satisfactory job, but it was a slow and expensive operation to carry out in the field.

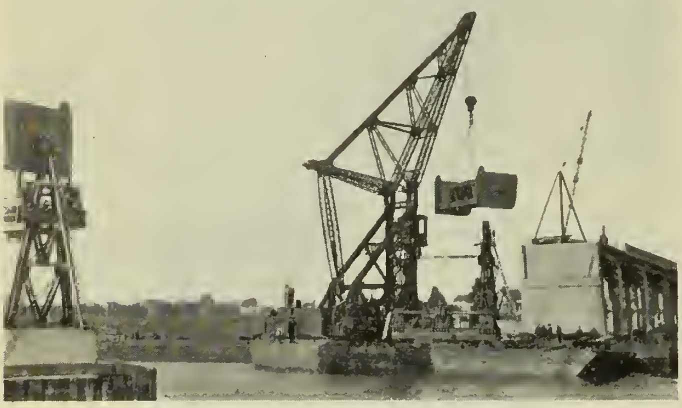

Fig. 19—Placing Trunnion Strut at Sorel.

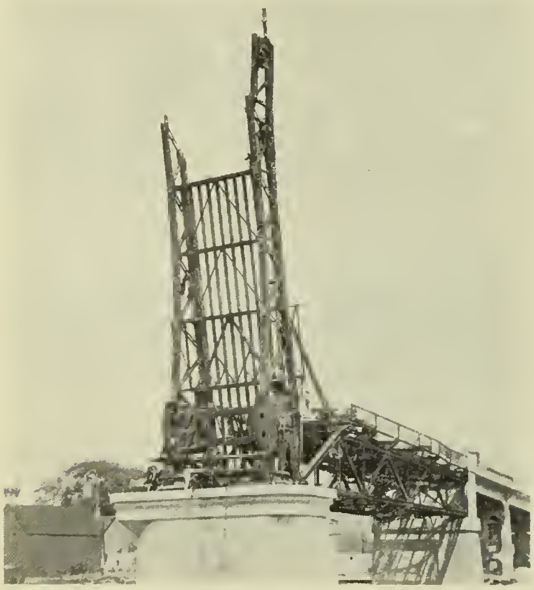

Fig. 20—Erecting Bascule Leaf at Sorel.

As soon as the trunnion bearings were located the machinery girder with the rack pinions, equalizer, etc., shop assembled to them, it was placed in position and the rack pinions lined up from the bearings. After this was done, the machinery girder was anchored in place and concrete was poured around it.

After one of the fixed spans adjacent to the bascule was floated in, a 12-ton stiffleg derrick was set up at its outer end and the steel was brought out to it on scows. The derrick then erected one leaf of the bascule. The girders, each of which had been shipped in one piece with the trunnions in place, were first erected. The girders were supported by the trunnions which rested in their bearings and also by blocking on the pier under their ends. To ensure the channel opening being maintained, the front ends of the girders were tied back temporarily to the fixed span. The trunnion and counterweight struts were then erected and connected up, after which the floor steel and bracing was placed. Before riveting was commenced the two girders were carefully lined up.

When the erection of the steel in the leaf was completed, the forms for the counterweight were built, the reinforcing steel placed and the concrete poured. While this was being done the machinery was placed in the machinery house and lined up. The derrick was then dismantled and transferred across the channel where it erected the other leaf in the same way.

As soon as the counterweight was poured, the roadway planking and the asphalt plank wearing surface were laid. The wooden floor was placed with the leaves in the open position, but the asphalt plank had to be placed with the bridge closed.

The contract called for the erection of the bridge to be completed by October 1st, 1931, but due to unavoidable delays in the completion of the piers it was only possible to place spans Nos. 4 and 3 in position during the summer of 1931. Span No. 2 was also completely erected but was not floated into position until the summer of 1932, upon completion of pier No. 2. The erection of the bascule span was also delayed until 1932. Unfortunately the first boat that passed through the opening after the first leaf was erected, but before the counterweight was poured, collided with the leaf and seriously damaged both girders, necessitating their removal and partial re-building. The bridge was opened on October 9th, 1932, and has operated successfully since.

Fig. 21—Completed Bridge, Sorel.

Sorel

At Sorel barge shipment direct from the shop to the site was adopted in preference to shipping by rail, as this permitted of lifting the steel direct from the barge to position in the bridge.

For the erection, no one piece of equipment was suitable for the whole job and it was found economical to combine the use of 15-ton derrick scows, a 75-ton floating crane, and a stiffleg derrick. By using the one most suitable for each operation an economical erection programme was developed.

In order to allow of easy and accurate setting of the trunnion bents, they were built with loose base plates which were accurately set in place on the piers before the bents arrived. Recesses were left in the piers in which the base plates were set to exact level. There were three base plates under each bent. These plates were brought to dead level and the same elevation with a straight edge and spirit level, after which the two sets on each pier were checked for elevation with a precise level. Each plate was brought to position and held there by means of levelling screws and anchor bolts. As soon as the plates were set and checked they were grouted in. Working lines were then established on the top of the pier and on the base plates parallel to and at right angles to the centre line of

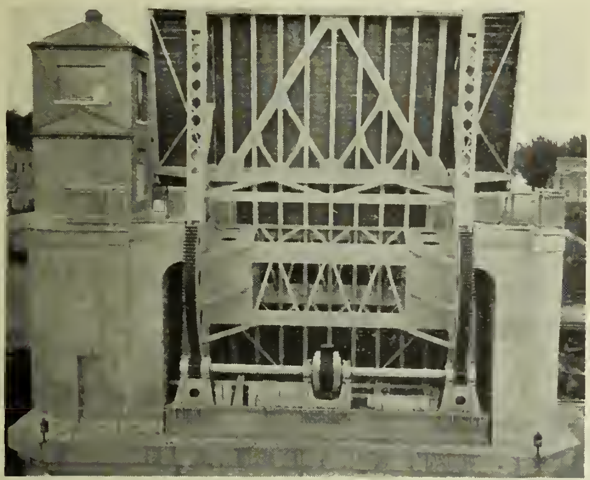

Fig. 22—End View of One Leaf, Sorel.

the bridge for use in locating the trunnion towers corresponding to the centre lines placed on the towers in the shop.

The trunnion towers, which were shipped in one piece, as previously noted, were placed by the derrick scow as shown in Fig. 18. The trunnion bearings were brought to correct line by shifting the towers on the piers, but without moving the bearings on the towers. The towers were then bolted down to the pier and the elevation and level of the bearings were checked. They were found to be correct without any shimming or adjusting, thus entirely justifying the shop assembly procedure.

The trunnion struts and machinery girders were the next pieces to be erected. Each of the former weighed 51 tons and the latter 28 tons. The method to be used in their erection was given a great deal of study, and the final decision was to use the Montreal Harbour Commissioners' 75-ton floating crane to place these four heavy pieces. The crane left Montreal at noon, on June 21st, 1932, and due to a favourable wind reached the bridge site about 6 o'clock. It immediately placed the trunnion strut on the Sorel side. Next morning it placed the machinery strut on that side and then crossed the channel and placed the other two units, completing its work by noon. Figure 19 shows one of these operations. To make the use of the floating crane economical it was essential that the operation be carefully planned and organized so that the crane on its arrival had only the four lifts to make. Without going to expensive overtime, there were about six working hours available, since the crane was only allowed away from Montreal harbour from Friday noon to Monday morning.

The following alternative method of erecting the trunnion struts and machinery girders was developed for use in case any unforeseen developments made it impossible to obtain the use of the 75-ton crane. The machinery shipped on the machinery girders was to be removed from them so that the 15-ton derrick scow could place the girders immediately after placing the trunnion towers. The machinery was then to be replaced on the girders by the scow. The approach spans were to be erected next by the same method as was actually used and which will be described later. On completion of one approach span a 50-ton steel ginpole was to be set up with its foot on the top of the pier and with its top guyed back to the approach span on which a hoisting engine to handle the hoisting lines was to be placed. The guys were so arranged that the pole would have sufficient fleet to pick the trunnion strut off a barge moored in front of the pier and lift it into position on its bearings. The ginpole and hoisting engine were then to be taken across the channel where the operation was to be repeated. This method would have been somewhat more expensive and a great deal slower than the one used.

When the machinery girders were fully riveted to the trunnion towers the alignment of the trunnions and trunnion bearings was again checked and found to be correct. The holes for the bolts connecting the trunnion bearings to the bents were then reamed and the bolts placed.

The approach span trusses on the Sorel side, each of which had been shipped from the shop in two pieces, were assembled on a scow and lifted into place by a derrick scow and a stiffleg derrick which had been erected on the end of the concrete approach spans. The stiffleg derrick then erected the remainder of the approach span steel and was moved out to the end of that span adjacent to the bascule. The derrick had a 100-foot boom and was used to erect the bascule leaf.

It first placed the tail end section of the bascule trusses and the counterweight strut. The lower ends of the trusses were tied to anchors previously placed in the pier which allowed the erection of the remainder of the span before the counterweight was poured. Figure 20 shows the placing of one of the last sections of the truss. As a clear navigation channel had to be maintained at all times, the leaves were necessarily erected in the open position. As soon as the steel in the leaf was all erected, the forms for the counterweight were built and the concrete poured. The stiffleg derrick also placed the machinery units in position on the piers after which the machinery houses were built around them.

On completion of the erection of the leaf on the Sorel side, the stiffleg derrick was moved across the channel and the other leaf was erected in the same way.

The bridge was completed in the late fall of 1932 and was opened to traffic at that time. Figure 21 shows a side elevation of the finished bridge and Fig. 22 is a view of the operator's house and operating racks and pinions on the Sorel leaf.

The superstructures of all three bridges were constructed by the Dominion Bridge Company Limited under the direction of Mr. F. P. Shearwood, M.E.I.C., chief engineer. The substructure of Norwood street was built by Foley Bros. of Winnipeg; of Gaspé by Dufresne Construction Company Limited, of Montreal; and of Sorel by Church Ross Company Limited, of Montreal.

The Montreal Neurological Institute and its Equipment

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and
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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY—This building is for the treatment and study of diseases or injuries of the brain and nervous system. In addition to hospital wards, it contains extensive facilities for neurological research and investigation. The special features in its equipment are described particularly with reference to the service requirements in the wards, operating rooms and research laboratories.

The Montreal Neurological Institute is designed to take care of all cases in which there is a structural defect in the nervous system, whether the treatment is to be medical or surgical. All cases, whether public or private, are studied by the newer methods of investigation. These cases include immediate and late results of injury whether sustained during birth or later in life. They also include inflammation, degeneration and tumours of the nervous system. One half of the building is given over to scientific study of disease problems that are related to the nervous system. The remaining half of the building is devoted to actual care of patients.

The building is located on the east side of University street above Pine avenue, and is directly north of the McGill Pathological Institute to which it is connected by means of an underground tunnel. It also connects with the Royal Victoria Hospital on the west side of University street, by means of an overhead bridge.

The building is an eight storey and basement structure, built in modified Scottish baronial style to conform with the architecture of the adjacent buildings. Three of the floors are used for hospital purposes, two of which contain public wards, and one, private and semi-private rooms. One floor is given over to operating rooms and consulting offices. Two floors are devoted to research and animal experimentation. The balance of the building is given over to living quarters and general purposes. The building is jointly operated by McGill University and the Royal Victoria Hospital.

Prior to the design of the mechanical equipment, an extensive tour of hospitals and allied institutions was made, especially in connection with laboratory equipment and the housing and handling of various species of animals necessary for research.

Heating System

The building is heated by hot water with forced circulation and convertors for heating the water and the pumps are located in the basement of the Pathological Institute. Both a.c. and d.c. electric current are available, and in order to ensure against interruption of service, the circulating pumps are in duplicate, one with a.c. and one with d.c. motor. The temperature of water in the convertors is controlled by means of graduated action thermostats and pneumatically operated valves, etc., with a range of 100 to 190 degrees F. This was done in order to secure control over an unusually wide range of temperature. Steam is obtained from the boiler plant of the Royal Victoria Hospital, high pressure steam mains being brought through the tunnel under University street connecting the plant with the Pathological Institute. The mains are duplicated and provided with steam flow meters of the integrating and recording type. This steam is used both for the Pathological and Neurological Institutes; the condensation from each building is metered separately in order to charge each with its proper share of cost. All piping of two inches and larger throughout the building has welded joints. Reducing valves and other such equipment liable to require maintenance are duplicated or provided with by-pass connections to ensure against interruption of service. A steam separator is installed on the medium pressure steam line to ensure clean dry steam for sterilizers. All condensate flows through an economizer used for heating domestic hot water in connection with the hot water tanks. From here it flows through a condensate meter to an electric pump which returns it to the hospital boiler plant. All heating mains and other distribution piping are in tunnels under the basement. All radiators on the hot water heating system are cast iron and are tested for 100 pounds working pressure. There is a total of 13,000 square feet of radiation in the building.

Fig. 1—The Montreal Neurological Institute.

Ventilating System

The building is ventilated throughout by means of two supply and four exhaust systems. One of the supply systems takes care of the operating rooms and the other the balance of the building. One of the exhaust systems takes care of operating rooms alone, one is for general requirements, one for the animal section, and one for toilets and utility rooms. The squash court is provided with a separate disc fan and gravity inlet.

The two supply systems are provided with a common pre-heater, filter and air washer but with separate re-heater coils and fans, all located in the fan room in the basement. Each supply system is provided with an electrically controlled pneumatic damper which closes when the fan for

Fig. 2—Photographic Department.

that system is not in operation, thus preventing either fan from drawing back from the other system. The filter is of the automatic, self-cleaning "belt" type, and is installed because of the necessity of providing air as clean as possible for the building. The air washer is of a simple type and is intended principally for supplying and controlling humidity. No provision is made for recirculating any air exhausted from the building. The heating stacks have thermostatically controlled pneumatic by-pass and shut-off dampers, for controlling temperature of the air. The pre-heater stack is provided with a thermostatically operated pneumatic valve which allows steam to enter when the outside air temperature falls below 35 degrees F.

Manually operated pneumatic dampers are provided in the supply and exhaust to the lecture theatre, so that ventilation may be cut off from this room when it is not in use. Fan motors for the two supply systems are a.c., slip-ring, variable speed type.

Exhaust fans are located in the pent houses. The toilet exhaust fan, which runs continuously, is in the upper pent house. The other exhaust fans are in the pent house above the eighth floor. Electrically controlled pneumatic dampers in the outlets from each fan close when the motors are not running, preventing down-draughts into the rooms. The motors on the general and operating room exhaust fans are a.c., variable speed, slip-ring type, all others are constant speed. All exhaust fan motors are equipped with pilot lights and stop buttons located in the basement fan room. All the fans in pent houses are equipped with special sound deadening and absorbing bases. This is in order to guard against any possibility of transmitted sound or vibration likely to cause annoyance in the lower portion of the building. Special silent type electric motors are used throughout.

Plumbing System

Various items of the plumbing equipment will be described in the detailed accounts of the various rooms and departments.

Since the building has no typical floors, it was necessary that all interior groups of risers be very carefully studied in order to place them in positions where least space would be wasted and at the same time form an economical and practical arrangement. Piping in general is concealed throughout. In laboratories and other portions where future changes are likely to be made, certain services are exposed. Plugged outlets are provided on walls where no equipment is now installed. Heavy cast iron pipe is used for soil piping except where acids and chemicals are used, in which case, duriron pipe is installed with duriron traps on fixtures. All domestic hot water and cold water piping up to and including one inch is of brass pipe with screwed brass fittings.

Hot water for domestic purposes is heated in two storage type heaters located in the basement of the Pathological Institute. Each heater has 475 Imperial gallons storage capacity and a heating capacity of 500 Imperial gallons per hour. Steam for heating is supplied to the coils through self-contained, thermostatic temperature regulating valves. Cold water supply to tanks is admitted through the economizer previously mentioned under heating. Forced circulation is used in the domestic hot water system and a small electrically-driven centrifugal pump is used for this purpose.

Two separate vacuum services have been installed. One with moderate vacuum, is piped to outlets in all laboratories for use in various technical processes and to wards for wound drainage. The other is a high vacuum service for the operating rooms. The vacuum pumps are of the rotary type, direct connected to electric motors. The vacuum service for the operating rooms is maintained at 26 inches of mercury at the pump. The general vacuum system is under automatic control at 12 inches to 17 inches of mercury. Cocks for vacuum services are of the laboratory gas cock type with tip drilled and a screw plug provided

Fig. 3—Lecture Theatre.

for all cocks which are used only infrequently. All vacuum piping is brass with screwed brass fittings.

Compressed air is supplied by a small electrically driven compressor and piped to all operating rooms and to the principal laboratories. Cocks are similar to vacuum cocks and piping is of galvanized steel.

Electrical

Electric power for driving motors and lighting is supplied from the power house of McGill University to a substation feeding both the Pathological and Neurological Institutes. All circuits from the power house are duplicated. The services provided to the Neurological Institute are, alternating current, three-phase, 230 volts, alternating current, single-phase, 3-wire, 230-115 volts, and direct current, 3-wire, 230-115 volts.

The direct current service can be supplied either from the circuits of the Montreal Light, Heat & Power Consolidated through motor generator sets or from the steam-driven sets of the university. Provision is, therefore, made

Fig. 4—Typical Four-Bed Ward.

in the institute to allow for all important services to be transferred to direct current in emergency.

The main switchboard in the Institute is located in a special room in the basement and is of the NoFuze, dead front type, equipped with circuit breakers. The saving in space with this type of switchboard was considerable. From this board, light and power feeders are run in a vertical shaft to panel closets on each floor. All electrical services for each floor are controlled through panel boards installed in these closets.

Power equipment is mainly concentrated at two points, the exhaust fans and elevator controls being in the ninth floor pent house, and the air-conditioning equipment, supply fans and pumping equipment on the basement floor. Direct current power is supplied to the pent house for elevators, and also to panels on the second and sixth floors for distribution to d.c. service outlets in the photographic department and all laboratories.

Lighting panels on each floor are 3- to 2-wire, 115-230 volts, with plug fuse only in branch circuits. Each panel has a separate section with circuits controlling emergency lighting for the three operating rooms, stairways, corridors and exits. These emergency sections are on a separate riser, controlled by a 150-ampere, automatic a.c.-d.c. transfer switch in the switchboard room. Lighting of public spaces and stairways is controlled by group switching in the ground floor office. Lighting of ward corridors and public wards on each floor is controlled from the nurses' stations.

Due to the exceptionally close regulation required for the operation of large Coolidge tubes, the X-ray power supply is an entirely separate system, including transformer, 230-volt feeder, and distribution panel in the X-ray department. This power feeder also supplies outlets on the operating room service panels, for portable X-ray machines. A separate lighting panel controls all special lighting, X-ray viewing boxes, and dark room power.

A standard type nurses' calling system is provided for all private rooms and wards. On floors where there are two control stations, the annunciators are cross-connected with an indication to register any unattended call from the other section. At each control station there is an emergency button that will give an alarm and register on an annunciator in the first floor office, in case a patient may leave by way of the stairs. In the ward kitchens and utility rooms there are duty stations to indicate any room call and the section from which it came.

A paging system is installed, consisting of a master control station at the telephone switchboard in the Royal Victoria Hospital, from which code calls are automatically sent out to sounder units located at twenty-four points throughout the building. The sounding units consist of a magnetic plunger striking on a bakelite disc and are adjustable for volume of sound. The sounders operate from a low voltage relay controlled by the set-up at the master control station.

For the various groups of offices there are return call signal systems between the private offices and the office of the secretary for each section. There are also signal systems between the lecture theatre and the porter's office, lecture theatre and lantern, also from each operating room panel to nurses stations and laboratories. The operating room buttons consist of special elbow pushes.

The clock system consists of a self-winding master clock, controlling twenty-seven minute-impulse secondary clocks throughout the building. Batteries and charging equipment are located in the switchboard room in basement and the master clock in the enquiry office on the ground floor. Secondary clocks are minute-impulse, flush type, 10-inch or 12-inch dials with dull aluminum bezels.

A complete conduit system has been provided for future installation of a closed circuit coded fire alarm system. The equipment has not yet been installed, but provision has been made for tying in the new system with the existing system in the Royal Victoria Hospital.

Watchman's stations consist of twenty flush type key stations for operation of portable clock, located so that a

Fig. 5—Ward Kitchen, 2nd floor.

complete inspection of the building is covered on each round of the watchman.

Telephone service is controlled from the main switchboard in the Royal Victoria Hospital. Distribution is made from flush cabinets located in panel closets on the first, fourth, and seventh floors. Outlets in private rooms and wards consist of jacks installed in the room nurses' calling system plate. Telephone service is provided in all laboratories, offices, control stations and elevators.

A complete conduit system was installed with the required outlets for a future radio system. Provision was made for outlets in all private rooms and wards, also in each room of the staff quarters on the eighth floor. On the hospital floors there are outlets at each nurses' control station so that programmes may be received and distributed to the head sets in the wards, under the control of the floor nurse. In the major operating room, provision is made for the future installation of a microphone and a sound projector so that spectators in the glass-enclosed gallery may readily hear the remarks of the surgeon at the operating table.

Elevator

The building is provided with two elevator shafts to allow for one service and one passenger elevator. At the present time the service elevator only is installed and is used for service and passengers combined.

The hoisting machine is of the single wrap, geared-traction, auxiliary micro-levelling type, operating on 220 volts d.c., with full automatic push button control.

Special cork sound-proofing insulation is provided under the machine and controller to prevent transmission of noises and vibration to the building structure.

The car platform is 5 feet 6 inches wide by 7 feet 11½ inches back to front, outside measurements. The cab is of standard stock design, consisting of sheet steel panels with baked enamel finish and is equipped with top emergency exit, aluminum hand rail and manually operated Bostwick gate. The floor is covered with ¼-inch rubber tile flooring. A telephone is installed in the car. Hatchway doors are equipped with manually operated door closers and holding latches. Electrical interlocks are provided on all doors to prevent movement of car when any door is open.

The heating, ventilating, plumbing and electrical equipment has now been described in a general way in connection with the building as a whole. A description will next be given of certain special features, including the sterilizers, kitchen equipment and refrigeration, in connection with the various rooms in which they occur.

Basement

The basement is devoted largely to rooms required for the general purposes of the building. Most of the piping in connection with various services is in tunnels under the basement floor. On this floor are located janitor's quarters and living accommodation for certain of the female staff of the hospital. The fan room, lower part of the lecture theatre, a sterilizer room and storage room are on this floor. The transformer and main switchboard vault is also on this level but off the passageway to the Pathological Institute. A small switchboard room is also provided near the bottom of the elevator shaft.

The transformer vault is divided by partitions into two portions, the outer contains the low tension a.c. and d.c. switchboards and also the operating mechanism for the switches on the 4,000 volt incoming a.c. feeders. The inner portion contains the transformers for light, power and X-ray, also the oil circuit breakers in the 4,000-volt feeders, together with their disconnecting switches. Open bus-bars are used on 4,000-volt circuits while the low tension connections are run in conduit.

The sterilizer room contains a 20- by 48-inch four drum dressing sterilizer. Provision is also made for a future mattress sterilizer.

First Floor

The first floor contains the entrance hall, enquiry desk, head nurse's office and necessary cloak rooms. On this floor are also the photographic rooms and upper part of lecture theatre, and consulting rooms for the use of staff doctors.

The photographic department is equipped to take care of all classes of work necessary for the routine work of the hospital and for research. Special lighting is provided at one end of the room (see Fig. 2) for photographing specimens or subjects requiring intense illumination and is also used for making motion pictures of subjects where such a record may be of value. Micro-photographic apparatus is installed in a separate room, which has a special floor to avoid vibration being transmitted to the apparatus. This apparatus is extensively used in the work of the institute for making records of small specimens and microscopic slides.

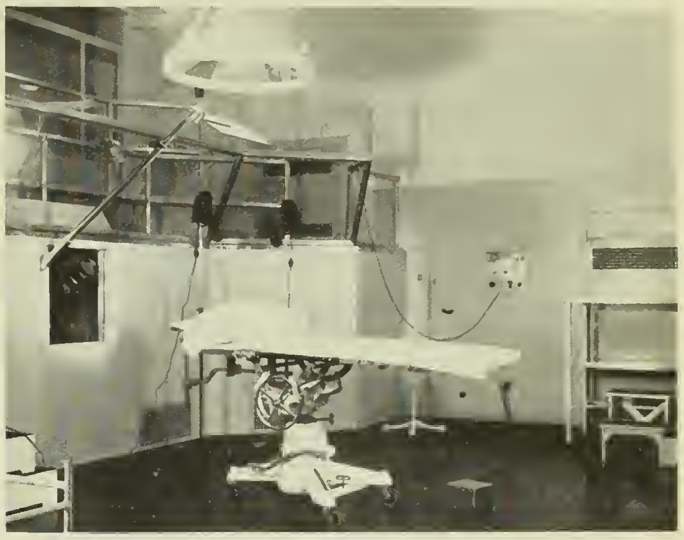

Fig. 6—Operating Room No. 1.

The dark room is equipped to take care of the developing of all classes of photographic work except motion picture film. The developing tank consists of a large alberene (soapstone) tank divided into three compartments with drainboards on either end. Each compartment is provided with a standing waste and a bell cold water supply inlet near bottom of tank. Each of the two outer compartments has a combination hot and cold water supply fixture. One drainboard has a shallow sink set in it and is used for hypo solution.

The lecture theatre (shown in Fig. 3) has a seating capacity of one hundred and twenty. It is two storeys high, running from the basement through the first floor. The seating is arranged in semi-circular rows in steep tiers. The room is used for general lecture and demonstration purposes, being so arranged that subjects may be brought in on the basement floor level. Due to the fact that there is no permanent table or desk for the lecturer, as all space available may be required at times for subjects under demonstration, the services, comprising water, gas, compressed air, drain and electrical outlets, are located in a recess in the wall beside the blackboard. The room is equipped with projection lanterns for handling all types of slides and opaque specimens. There is also provision for moving picture apparatus. Motor-operated blinds are controlled by a push button near the blackboard. There is both supply and exhaust ventilation in the room, supply outlets being located under the seating, and exhaust grilles in the ceiling. Radiators are thermostatically controlled.

Second, Third and Fourth Floors

The second, third and fourth floors, together with the operating suite on the fifth floor, form a hospital unit for the reception and treatment of patients. The second and third floors are used as public wards, the former for females, and the latter for males. The fourth floor is used for private and semi-private patients.

The second and third floors are similar in general arrangement and each contains a twelve- and a four-bed ward, two sound-proof observation rooms, diet kitchen, two utility rooms, dressings room, nurses' stations, small laboratory, continuous flow bath room, waiting, locker and storage rooms and lavatories.

The wards on the second and third floors are arranged so that the patients' beds are along blank walls with windows at the ends of the rooms only, as shown in Fig. 4. This aids in observing the condition of the eyes, an important feature of the diagnosis in the case of many patients. The one nerve of the brain that can be seen is the optic

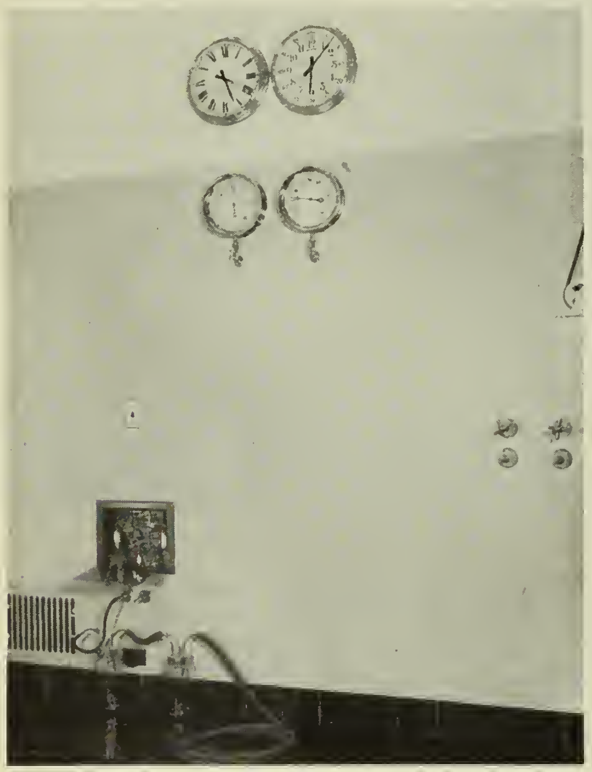

Fig. 7—Vacuum and Compressed Air Services and Electric Clocks in Operating Room.

nerve, which is visible through the lens of the eye. A study of this is a great help in the diagnosis of tumours of the brain. Due to the fact that there is a large expanse of blank outside wall where the beds are located, it was necessary to use concealed radiators. Permanent curtain rods are suspended from the ceiling to support curtains which may be drawn around beds for isolating patients. Vacuum cocks are located at various points in the wall for use in connection with wound drainage. A combination plate with nurses' call and electrical convenience plug receptacle is installed in connection with each bed, also an indicating dome light near the ceiling over each bed to show from which patient the call originated. Provision is also made so that each patient can be furnished with radio ear phones. Each ward has its own toilet room and bath room. Each ward has a nurses' station arranged so that the nurse may sit outside and have the ward under full observation through large windows.

Each of these wards has its own utility room equipped to provide for ward requirements. The utility room for the twelve-bed ward contains a utensil sterilizer, an instrument sterilizer, a bed-pan washer, bed-pan rack, utility sink, disposal sink and gas plate. There is also provision for a future bed-pan sterilizer. The utility room for the four-bed ward has the same equipment as the other, except that there is a bed-pan sterilizer instead of a utensil sterilizer.

Each hospital floor has one continuous-flow bath, used in the treatment of mental and nervous ailments. The important feature in connection with this bath is the constant temperature maintained by water continually flowing in through a number of inlets after passing through a thermostatically controlled mixing valve. These baths are 6 feet 6 inches long and are equipped with a canvas hammock so that a patient may lie comfortably when stretched out full length.

The second and third floors each have a dressings room, fully equipped for dressing wounds. Patients are wheeled into these rooms in their beds, thus avoiding dressings in wards which might disturb the other patients. There is an instrument sterilizer and an all-service sink in each of these rooms.

The fourth floor which is devoted to private and semi-private patients has two three-bed wards and nine private rooms. Four of the private rooms have private baths, the balance have basin and toilet only. There are two utility rooms on this floor, one for the three-bed wards, and one for the private rooms.

The three-bed ward utility room contains a disposal sink, bed-pan washer, bed-pan sterilizer, instrument sterilizer, gas plate and utility sink. The private patients' utility room contains a utensil sterilizer, combination bed-pan and utensil sterilizer, instrument sterilizer, gas plate and utility sink. Each private patient's toilet has a bed-pan washing jet built into the bowl. Each private room has a vacuum outlet for wound drainage. There is provision for telephone service in addition to nurses' call and radio. Concealed night lights are built into the walls near the floor. Each of the three floors has a built-in blanket warmer.

All food is cooked in the main kitchen of the Royal Victoria Hospital and brought across the bridge in electrically heated trucks. One ward kitchen (Fig. 5) is located on each floor, equipped for light cooking only and for serving meals from the electric trucks. The kitchen on the second floor has a dishwashing machine, all dishes in the building being brought to this floor for cleaning. Silver is washed in the sinks in each kitchen. All kitchen equipment is polished monel metal. Each kitchen has a hot water urn, a coffee tricolator, and a two-burner gas plate, all standing on a steam heated dish warmer which also acts as a serving stand for the electrically heated food trucks and is equipped with electric services to which the truck may be attached. The room also contains a monel metal sink, a combined serving table, storage cupboard and tray racks. Each of the kitchens on the second, third, and fourth floors is provided with individual refrigerators for general food storage, and in addition the kitchen on the latter floor has a refrigerator divided into six separate lock-up compartments in which patients may keep their own special supplies. All refrigerators are self-contained units and each is equipped with ice-making trays.

Each floor has medicine sinks located near each nurses' station, and one scrub-up sink located centrally in the corridor.

Each of the three floors has supply and exhaust ventilation for wards and utility rooms. All toilets and ward kitchens have exhaust only and corridors have supply only.

Fifth Floor

The fifth floor contains the operating suite, X-ray department, and consulting rooms for the neuro-surgical staff. The operating suite consists of two operating rooms, anæsthesia room, sterilizer room, instrument cleaning room, surgeons' rest room, linen room and visitors' room.

Operating room No. 1 which is shown in Fig. 6 is the larger of the two, and has a spectators' gallery with accommodation for twenty persons, which is divided from the operating section of the room by a plate glass screen. Access to the gallery is had from the visitors' room alongside. The operating room is finished in green tile and has a black soft rubber floor. This type of floor is necessary to reduce the fatigue resulting from the long operations common in brain surgery, some of which last from five to eight hours. They have to be done very slowly so that there will be as little bleeding as possible and because the tissues must be very carefully handled. The brain itself is insensitive to pain, and many of the operations are carried out under local anæsthesia with the patient fully conscious throughout the entire procedure. The principal lighting fixture is a Zeiss Pantaphos, arranged both for vertical adjustment and travel across the room on a rail attached to the ceiling. This type of fixture has been found particularly satisfactory for neuro-surgery, on account of its shadow-free field of operation, intense and uniform illumination both over the surface and in the depth of the incision. There is also a glass filter to absorb the heat rays and also to approximate daylight in colour. This light source takes 150 watts. In addition, portable spot lamps with floor stands are provided to supply high intensity local illumination when necessary. There is also general ceiling lighting for use when operations are not taking place.

Space is provided under the spectators' gallery for photographic apparatus. The camera is placed behind a window in the front of the gallery and pictures of operations can be taken by means of a mirror supported by an adjustable arm directly above the patient. Provision is also made for special high intensity illumination when moving pictures are being taken.

Fig. 8—X-ray Apparatus.

There are two electrically heated instrument sterilizers installed in a recess, one using water and the other oil as a sterilizing medium. The oil sterilizer is used principally for small steel instruments with sharp points or cutting edges. These sterilizers are placed in the operating room since it is often necessary to re-sterilize instruments during long operations without leaving the room.

One of the hot water heating radiators is under the gallery, the other in a metal enclosure in the side wall. There is also an additional steam radiator in an enclosure in the side wall, connected to the medium pressure steam system, which is used when heat is required in the operating room but not in the rest of the building, or to boost up the temperature quickly when necessary in an emergency. All the radiators are thermostatically controlled by means of two thermostats, one controlling the hot water radiators and one the steam radiator. Each thermostat is equipped with a lever, providing quick adjustment four degrees above and below the normal temperature setting. In addition the thermostat for the steam radiator has a lever by which the radiator may be turned on or off.

Fig. 9—Laboratory Service Shelf with Removable Work Table and Fixed Shelf and Services.

Vacuum and compressed air services are brought to the operating room and terminate in a monel metal box located in the wall (Fig. 7). This box contains sensitive adjustable vacuum and pressure regulators. Ten-inch diameter vacuum and pressure gauges are mounted on the wall facing the operator and are connected to the controlled vacuum and air services. Additional pressure and vacuum cocks are also provided which are connected directly to the lines ahead of the controls. The vacuum service in connection with brain surgery is very important as it is frequently used to remove tumour tissue from the brain by a suction instrument connected to this service which has to be carefully controlled. As mentioned earlier, there is a separate vacuum pump for the two operating rooms.

Four different electrical services are brought to a large plate on the wall provided with receptacles and switches for their use and control. In addition a cable is run from this plate carrying all services to a large portable metal spider box on the floor which has a number of plug receptacles to which attachments can be made. Electrical services provided are 230-volt a.c. for X-ray, 110-volt a.c. and d.c. for general purposes, and a 4-6-volt d.c. service operated from a storage battery located in the panel cupboard on the fifth floor. This latter service is brought to three-point polarized receptacles and is used for various small instruments and for emergency lighting. It also provides current for operating the small head lamp which the operator wears strapped to his forehead for certain operations. The storage battery is charged by a trickle charger. The wall plate previously mentioned also has switches controlling the room lighting and an elbow-operated push button for emergency use to summon aid to the room.

The operating room has one standard secondary clock with hours and minutes and one seconds-indicating clock on separate dial with a single stroke bell to indicate fifteen seconds periods. This seconds clock is started and stopped by a tumbler switch on the electric service plate.

A rim flushing floor drain with hot and cold water is provided for the operating room.

The operating room has its own supply and exhaust ventilating system as mentioned previously. This feature is included in the design to permit control of the air supplied to operating and anæsthetic rooms. This air is maintained at a temperature and relative humidity higher than that provided for the rest of the building. This is important as cases of explosion of anæsthetic fumes have been traced to sparks due to static electricity. The high humidity also reduces evaporation from the surface of exposed tissue at the high temperatures sometimes maintained as both the temperature and humidity are chosen for the benefit of the patient rather than for the comfort of the other occupants of the room. Supply air is brought in at both the floor and ceiling. The exhausted air is taken from the floor and ceiling at the opposite side of the room. Air is also supplied to the small photographic cubicle under the gallery. A certain amount of air is exhausted from the hood over the sterilizers in the sterilizer alcove.

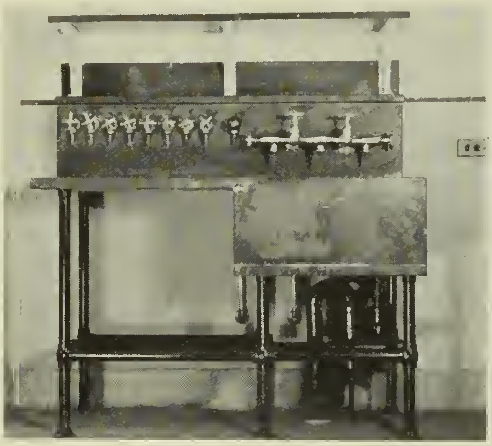

Fig. 10—Laboratory Sink, with Three-Outlet Supply Fixture, Steam and Cold Water Cocks.

A portable X-ray viewing cabinet in the operating room enables the surgeon to consult X-ray photographs at any time.

A door on the south side of the operating room leads into the instrument cleaning room, which is equipped for cleansing instruments and other apparatus. The sink is of monel metal with two compartments and two drainboards. Storage cupboards are provided for instruments and supplies.

Operating room No. 2 is generally similar to No. 1 but is smaller. No photographic cubicle is provided. A door communicates with the X-ray room permitting the patient to be moved to the X-ray apparatus so that necessary photographs may be taken conveniently and with little delay. The room is intended principally for encephalography and ventriculography which involve the injection of sterilized air into the cavities within the brain and over the surface of the brain, making certain conditions of inflammation or growths show up when X-ray pictures are taken.

The sterilizer room for the operating suite contains one 48- by 20-inch four-drum dressing sterilizer, a large utensil sterilizer, two instrument sterilizers, sink and drainboard and rim flushing disposal sink. The dressing sterilizer is equipped with recording and indicating thermometers in the condensate outlet from the chamber, thus ensuring that all air is vented and that the steam in the drum reaches the full temperature corresponding to its pressure necessary for proper sterilization. The usual indicating pressure gauges are also installed, both for safety and as a check against the thermometers. This room has both supply and exhaust ventilation.

The surgeons' scrub-up sink is installed in the passageway outside the operating rooms, and is large enough to accommodate four persons and has four combination hot and cold water supply fittings with blade handles.

The anæsthesia room, which is situated adjacent to the operating room, is equipped with sink and drainboard and a small refrigerator. Provision is also made for the future installation of an instrument sterilizer. Supply and exhaust ventilation is provided.

The X-ray room located alongside operating room No. 2 is equipped with all X-ray apparatus necessary for photography and fluoroscopic work (see Fig. 8). The main table is motor driven and has universal adjustments provided for making pictures with the patient in any position. Transformers for X-ray apparatus are located in a separate cubicle opening off the room, while the timer and control apparatus are located in the room.

The X-ray dark room is equipped to handle all the developing work for this department. The insulated developing tank is provided with a separate cooler for chilling wash water in hot weather. The cooler is cooled by a small individual refrigeration unit in the basement. The temperature of the water supplied to the tank is controlled by a thermostatic mixing valve. The use of this chilled water permits the technician to maintain uniform conditions of temperature for developing, fixing and washing films both in winter and summer, and has been found to improve the quality of the work produced. There is also an alberene sink and a motor driven film dryer. Exhaust ventilation only is provided for this room.

Rooms for X-ray viewing and film storage are located across the corridor from the X-ray room and are equipped with viewing boxes and stereoscopic viewing apparatus.

Sixth Floor

The sixth floor is devoted mainly to laboratories used for research work. It also contains a library, offices of the Director of the Institute, his secretary, an office for the neuro-pathologist and the chemist, a special room for cleaning glassware and rooms for general storage and the storage of specimens preserved in formalin. There are two chemical laboratories, large laboratories for the research fellows and routine technicians and several small private laboratories for special research work.

One of the chemical laboratories is used for the general chemical work of the institute. This laboratory contains an alberene stone fume cabinet with water bath and duriron sink, and services consisting of gas, hot and cold water, compressed air, vacuum and medium pressure steam. These services are arranged to be controlled from the apron on the outside of the cabinet when the cabinet is closed. The electrical plug receptacles and light and fan switches are also located on the front apron. The air from the cabinet is exhausted by means of a duriron exhaust fan. A chemical table in the centre of the room has a lead-lined trough running down the centre the entire length and emptying into an alberene sink at one end. Services are located along the centre of the table over the trough and include hot and cold water, gas, compressed air, vacuum and electrical plug receptacles both a.c. and d.c. In common with the other laboratories and certain special rooms, this laboratory is provided with a wooden service shelf which is about 10 inches wide and contains groups of services, each consisting of a copper funnel-type sink 6 inches in diameter inside fitted with duriron trap, a hot and cold water gooseneck supply fixture fitted with special removable hose connection tip, a double gas cock, and single compressed air and vacuum cocks, all as shown in Fig. 9. Duplex electrical plug receptacles for a.c. and d.c. are located in the wall above each service group. All piping for the service shelves is grouped under the shelves along the wall where it is of easy access for alterations and extensions. The front of the shelf has an apron 8 inches deep which partially hides the piping behind it. This arrangement for services was chosen to provide for flexibility in furnishings as it allows work benches of varying

Fig. 11—Alberene Stone Sink with Fume Hood in Research Laboratories.

heights or sizes to be placed in front of it. These work benches can thus be changed or removed at will without disturbing permanent piping or fixtures. Where radiators are under the shelves, grilles are countersunk into the top of the shelf and sheet metal enclosures lined with asbestos are placed around the front and sides of the radiators, thus shielding the legs of any one, working at the bench, from radiant heat.

All the alberene sinks and fixtures used in laboratories are of special design, as shown in Fig. 10. Each sink has an alberene shelf over the top of splash back, 6 inches wide. The supply fixture is of special design with four valves and three outlets so that hot, cold and mixed water can be drawn at the same time. Each of the three outlets has a special removable serrated nozzle to allow connection either to rubber tubing or to a standard hose fitting. Small ⅜-inch compression cold water cocks are located on the splash back over the drainboard and arranged with outlets to take rubber tubing. These outlets are used when it is necessary to allow a small quantity of water to flow continually over specimens in jars during the course of preparation. In certain rooms the sinks are also provided with a steam cock supplying medium pressure steam. The handles of steam cocks are coloured red to guard against mistakes.

This chemical laboratory also contains a water still, a single drainboard alberene sink, a refrigerator and a high temperature electric oven. A shower head with pull chain valve is installed for use in case of accidents.

The other chemical laboratory is smaller and is used principally for research. This room contains a small fume cabinet, alberene sink, centre chemical table without trough or sink, and service shelf with two groups of services. The principal chemist has a combined office and laboratory with alberene sink and service shelf. The office of the Director of the Institute has a work bench fitted with a group of services but with porcelain sink instead of copper funnel.

The routine technicians occupy the largest of the laboratories. This laboratory has a service shelf with six groups of services. Cabinets are placed at right angles to the wall and project out from the work bench in order to divide the room into a number of small cubicles for individual workers or types of apparatus. This room also contains a small refrigerator, a large electric oven, electric incubators, and an alberene sink and drainboard. This laboratory is used for hardening, embedding, cutting, staining and mounting material that is to be examined, such as tumour tissue that is removed during an operation. Frequently the only means of properly identifying this tissue is by microscopic examination and such identification is of importance in determining the future outlook and indications for treatment. This room is also used for preparation of material for the various researches that are carried on.

The research fellows' laboratory is similar in general arrangement to that of the routine technicians. It is provided with service shelf with six groups of services. alberene sink and drainboard, also centre tables arranged for microscopic work.

The two small research laboratories are each provided with a service shelf and alberene sink. These sinks (shown in Fig. 11) are different from the standard in that they have a ventilated alberene hood covering the whole of the sink and drainboard. This is provided to remove odours or fumes when working with specimens which are being impregnated with formalin solution.

The glassware cleaning room contains a large double alberene sink of special design with drainboards on both

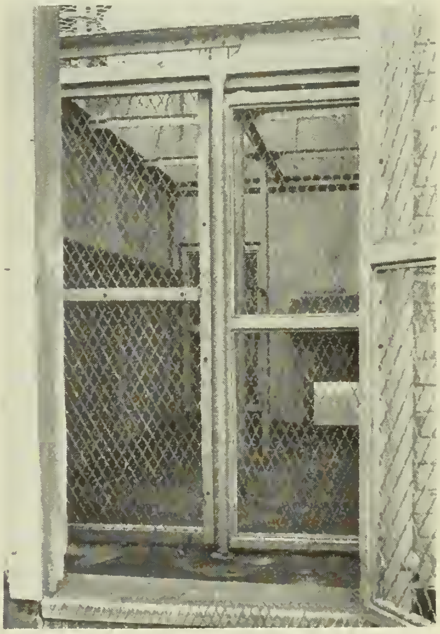

Fig. 12—Outdoor Animal Cage.

ends, extending through wickets opening into the routine technicians and research fellows' laboratories. Each sink compartment has a combination hot and cold water swivel supply fixture. One drainboard is cut to accommodate a special glass rinsing jet located in a monel metal cup. There is also a live steam cock located on the splash back of the sink to allow the operator to boil water in the sink.

Seventh Floor

The seventh floor is devoted to physiological researches into the action of the nervous system of animals and to the housing of animals.

The quarters in which the animals are housed consist of four rooms opening off a corridor and open air runways located on the roof adjacent to the rooms. The rooms are designed to house the larger animals, such as chimpanzees or large monkeys. They can also be used to contain cages for smaller animals. The wire enclosure around the runways and other equipment is made strong enough to take care of young chimpanzees only, which have approximately the strength of an ordinary man. An adult chimpanzee has the strength of about four men and is too difficult to handle in experimental work. Chimpanzees are used for observation of their behaviour under various conditions, their nervous system being the nearest to that of human beings. The entire animal quarters and corridor and its equipment is made "monkey proof" to prevent damage to the equipment, or animals, in the event of a monkey escaping from its cage. Each of the animal rooms contains a special drinking tap located in a flush monel metal box in the wall. The exposed part of the drinking tap consists of a spout and a lever handle. The spout is short and heavy and cannot be damaged very easily. The lever handles, however, are the only pieces of apparatus in the room that are not "monkey proof." These taps are installed for the use of chimpanzees who after they are once shown how to use them by putting their mouths to the tap and pressing down the lever do not try to damage or take them apart. Although they are very inquisitive and will try to dismantle everything, even using their nails as screw drivers to take out screws, after they are once shown that something is of real benefit to them, they will not try to damage it. This box also contains a hose connection with hot and cold water for cleaning purposes.

Fig. 13—Corridor to Animal Rooms.

The rooms are heated by enclosed hot water radiators controlled by individual thermostats in flush boxes behind heavy grilles. An enclosed steam coil is also provided in each room and connected to the medium pressure steam supply for use when the regular heating system is off and it may be necessary to provide heat for tropical or delicate animals. The lighting fixtures are flush with the ceiling with heavy reinforced glass plates on the front. The rooms opening into the corridor are provided with both solid wooden and sliding wire mesh doors. Each room has a swinging flap door and a wire mesh gate leading to wire mesh enclosed runways located on the roof as shown in Fig. 12. When the gate is open the animals can go back and forth through the flap door. If the attendant wants to keep the animal in or out, he shuts the gate. The gate is remotely operated from the front corridor or the passageway in rear of runways. The corridor serving the animal room contains a humidifier, a cage sterilizer, and a cage washing sink (see Fig. 13). The humidifier is placed behind a grille opening on the corridor and is of the fan circulating type, automatically controlled by a humidistat located in a flush box with grille in front. It is essential to have properly controlled humidity and temperature, as monkeys and chimpanzees are susceptible to pulmonary diseases. The cage sterilizer is of the built-in type and is large enough to take any of the cages used. The cages are sterilized by admitting steam directly into the closed chamber under atmospheric pressure. The sterilizer has a drain and large vent and an indicating dial thermometer located on the wall to show the temperature of sterilization. The cage washing is done in a deep alberene stone sink which also serves as an animal bath. The sink has hot and cold water, live steam for boiling the water, and a large quick opening gate valve in the waste. Each animal room and the corridor has exhaust ventilation only with a separate fan.

A special kitchen is provided for preparing food for the animals and contains a gas stove, monel metal sink and work table. A large refrigerated room for storing bulk food opens into the kitchen and is provided with a work table for certain operations in connection with the preparation of specimens requiring a cold atmosphere.

A gas fired incinerator is provided on this floor for the destruction of waste and rubbish originating in the animal department. A can washer is also located in the incinerator room.

The operating suite for animals consists of an operating room, a physiological room where various experimental tests are performed on animals under observation, and between these two rooms are located the sterilizer room and surgeons' scrub-up. The operating room contains a service shelf with one group of services, a general sink, compressed air and vacuum and a rim flushing floor drain. The electrical services are similar to those in the operating rooms on the fifth floor. A blanket warmer is located in a small work room adjacent to the operating room. The physiological room is supplied with the same mechanical and electrical services and equipment as the operating room.

The sterilizing room is equipped with a 36- by 20-inch, three-drum dressing sterilizer, instrument and utensil sterilizers, a disposal sink and one instrument cleaning sink and drainboard. It should be noted that this sterilizer room is completely equipped and provides for the possibility of as complete sterilization as is used anywhere for surgical work. A large scrub-up sink of sufficient size to accommodate three operators is provided in the scrub-up room. Supply air for ventilating is introduced into both the operating and physiological rooms and is exhausted from these rooms into the sterilizer and scrub-up rooms through grilles and swing doors.

There are also two laboratories on this floor which are used for special research. Each is equipped with a service shelf and an alberene stone sink and drainboard. Supply and exhaust ventilation is provided for both of these rooms.

Eighth Floor

The eighth floor is used as living quarters for the resident who is the chief interne, and five research fellows. There is also a squash court, the upper part of which is on this floor and the lower part on the floor below.

Two pent houses are located on the roof and contain all the exhaust fans and elevator machinery.

Wherever possible all material and equipment was of Canadian manufacture and a provision was made in all contracts which set a minimum wage per hour for workmen employed in the various trades.

Dr. Wilder G. Penfield, the Director of the Neurological Institute, together with his associates set the requirements for the building and those responsible for the design of the building and mechanical and electrical equipment were Ross and Macdonald, architects, McDougall and Friedman, consulting engineers, with Wilson and Kearns, associate consulting engineers, all of Montreal.

Modern Sewage Treatment Practice

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, November 1st, 1934.

SUMMARY—The paper gives a survey of present practice in sewage treatment, outlining the development of the processes now in use for sludge digestion and secondary treatment of the effluent. Sludge disposal is briefly considered, and some figures are given as to capacity and cost of a few typical installations.

Sewage treatment is distinct from sewage disposal since it involves the provision of works to subject the sewage to some form of change which will render it safe to discharge into a nearby water course. Sewage disposal may mean only the discharge of the untreated sewage. It is with "sewage treatment" that this paper deals.

Sewage treatment in a definite form had its origin in England and the first recorded sewage plant was that at Merthyr Tydvil in Wales in 1857. Since that time many investigators have endeavoured to improve on the original methods and devise ways in which such plants could be built at less expense, occupy less ground area and cost less to operate.

The author's conception of sewage is that it is a relatively large volume of water representing the used water supply of a city containing materials which cause it to be a menace to health and comfort. In passing through the households of the city the water picks up solids of human origin, both fecal and from bath water; the kitchen contributes more in the way of finely divided solids washed down the sink, grease, etc. The streets contribute more through manholes and occasional downspout water containing grit, leaves, sand, etc. Then in unknown ways there is always a mass of solids which have no place in a sewer but seem to end up there. In the author's experience this has gone to the extreme of automobile seats, 5-gallon gasoline tins, mattresses and other objects.

Some of these ingredients are of large size, others are in a state of comminution barely visible to the eye. Sewage treatment is thus essentially a problem in classification, removing from the sewage solids of various types by the best means available for handling those solids and collecting them into separate masses for final disposition in a manner most effective for that particular mass.

Roughly sewage contains three classes of solids: first, garbage, consisting of fruit skins, wood, bottles, rags, paper, hair and other objects which have an appreciable size and which may be incinerated or disposed of without odour and which on the other hand take up useful room in tanks; second, inert solids such as grit, sand, coal and other material which is not a nuisance from an odour standpoint; third, organic solids, usually of human fecal origin, vegetable solids and other particles of small size which cannot be retained long in the neighbourhood of habitations without causing trouble and complaint.

The means provided for removing these various solids from the sewage vary materially but in modern plant practice have been so thoroughly developed that it is merely a matter of selecting the proper sequence of units to achieve any desired degree of treatment.

Selection of a Method of Treatment

The selection of a method of sewage treatment, and the degree of refinement to which such treatment must be carried, are matters of extreme importance. They must be determined after careful study and consideration of a number of factors such as the use of the stream into which the sewage is discharged, the effect of sewage upon the inhabitants of other towns, the changes in population, the effect and character of the industrial wastes in the sewage, the suitable site for the plant having regard to adjacent inhabitants and the use of by-products from the plant. The degree of treatment required is usually determined by the officials of the local health organization; in the case of Montreal by the Provincial Board of Health, whose duty it is to protect the potable streams and to determine the remedial measures that may be used. In most cases the health authorities do not attempt to pass on the relative merits of different methods unless a method of experimental type or doubtful value is submitted. The decision as to the method to be used is usually the function of the municipal engineer, or the expert consultant engaged to study the problem and design the proper plant.

At this point it is proper to discuss the advantages of having a recognized expert carry out this important work. It is true that there are numerous books which describe the sewage treatment processes in use. Naturally these works are always somewhat behind the times and the art of sewage treatment is developing so rapidly that it is difficult even for one who spends his entire life in contact with it to keep posted in all the new methods proposed. Therefore, to follow a textbook blindly and design a plant on the basis of data given therein, may, it is true, provide a city with a plant which will operate, but does not give the city the benefit of advanced knowledge in the reduction of costs and increased efficiencies. Many cities place the burden of design of sewage plants upon their city engineer. However, the average city engineer is so burdened with other duties that he has not the time to delve into the mysteries of sewage treatment, and when faced with the design of a plant which embodies biological, bacterial, chemical and mechanical factors he often relies to too great an extent upon the proponents of methods which are proprietary. To obtain the maximum benefits of economical cost and operation, minimum size of plant and maximum efficiency requires an intelligent weighing of all factors, methods and costs, and the balancing of the benefits of one method against another as well as the disadvantages. This the specialist in sanitary engineering is qualified to do. He has made a special study of sewage treatment, the basic principles of the art, the constituents of sewage, the reactions of that material to various bacterial, biological and chemical processes and is skilled in the art of selecting a combination of elements which will so treat the sewage as to achieve the desired degree of treatment with the end of handing over to the city a properly designed plant which has been built and can be operated at a moderate cost. The specialist is usually well worth his fee and in many cases can save many times that amount for his clients. While the placement of the responsibility for design in the hands of the expert is the best way, in many cases there are men employed in the engineering departments of the large cities who have had training in sewage treatment and can design plants embodying modern practices. But, even in such cases, it would be wise for the city to call in a qualified consultant and have him check the factors embodied in the design.

Sewage treatment in its earlier phases included provision for removing solids from sewage by hand operations, namely, screens were hand raked, tanks were cleaned by flushing or hand shovelling or squeegeeing, materials were carried in barrows or carts. The development of satisfactory electrical equipment has perhaps been the most important factor in the complete mechanization of sewage treatment works. This development has been so great and the mechanisms provided have been so generally successful and satisfactory that today engineers when designing a plant make it as completely mechanical and automatic as possible.

Development of Methods of Treatment

As previously stated sewage treatment is an intelligent utilization of the forces of nature, biological actions, bacteriological functions and chemical combinations. All of these factors may be combined in the design of a single plant, or one or more of them only may be required to carry out the desired end. Modern practice has not reversed this employment of nature's functions but has made an attempt to assist her in the performance of her work.

To be more specific, the larger solids in sewage will

Fig. 1—Separate Sludge Digestion Plant 4 m.g.d., Kitchener, Ontario.

settle, thus employing gravity, a natural function; others are of such size as to be intercepted by a barrier, say a screen, another natural function. Thus in the average plant old or new, a bar rack or screen with openings of from one-half inch to two inches is the first unit in the plant, put there for the sole purpose of intercepting such solids as will be caught by the bars. The solids thus retrieved may be incinerated or burned, and as these solids in many cases are of a light nature and float on the surfaces of streams it is usually considered necessary to remove them even when further treatment is not required.

The grit, sand and such inert solids in sewage may also be readily removed. They are usually of a higher specific gravity than water, therefore if the velocity of flow is reduced to a certain point these particles will settle out and may be removed. This material may in many cases be removed from the plant and used as fill, especially if one of the modern types of grit chamber is used, wherein the organic material in the grit is removed from it.

The organic solids in the sewage are the most difficult to remove due both to their inveterate tendency to decompose and cause odours and also to their size. They require a combination of natural forces and possibly some chemical means to remove them. The bulk of these solids are of a higher specific gravity than water and the usual way to trap them is to provide a tank, which in reality is simply an enlargement of the sewer, where the velocity of flow will be so reduced as to allow a downward tendency to the solids instead of being carried along in a vertical plane. However, the very fine solids and many which are in solution cannot be effectively removed by plain sedimentation and the practice of late has been to intensify this tendency to settle by the addition of chemical coagulants to the sewage, which tend to agglomerate the particles into flocs or larger particles, which then have a tendency to settle. There are several ways of doing this, but due to the cost of some it pays to make a careful study of all before any steps are taken. This addition of chemicals may also be carried too far from the standpoint of future handling of the solids so precipitated, but means are available whereby the maximum precipitation may be obtained without affecting the ability to handle the solids by biological means.

The solids which are caught in settling tanks are known as "sludge." They are in a condition amenable to rapid decomposition and thus cannot be held at the plant for long periods without the possibility of odour. This has always been a recognized fact and even in the earliest plants provision was made for allowing these solids to undergo the natural function of decomposition which is a bacterial breakdown of the solids into inert components but which in the process of breakdown may produce disagreeable odours. On the other hand intelligent control of this process of breakdown shows that better results can be obtained with no odours. This is simply an understanding of the basic principles and the employment of bacteria of one type instead of those of another.

The first unit for this purpose was known as the septic tank in which the collection of the solids and their decomposition was carried out in the same tank, no sludge being transferred; this, however, has practically passed out of use except for plants for individual houses and very small groups. It had many disadvantages, one of which was that the solids piled up in the tank and eventually the effluent from it became worse than the raw sewage going in, as the velocity of flow through the tank, due to the accumulation of solids, was greater after a period of operation than when the tank was first put into operation.

Study of the faults of this operation led to the invention of the Travis tank in England, and its later successor, the Imhoff tank of Germany, which recognized the basic difficulties of endeavouring to do two operations of a different nature in the same unit. Both of these tanks provided an upper compartment in which the solids were removed from the sewage by settling; these solids then passed into the lower or digestion compartment and were allowed to undergo their natural function of decomposition. These were decided improvements, but due to the superimposition of the settling tank upon the digestion compartment and the fact that the flow line of the average sewer at the plant was several feet below the ground these tanks had to be very deep, and in cases where wet or rocky ground was encountered they were expensive to build. Many thousands have been built, but they still had faults. Frequently they "foamed," that is, upheaved digesting solids over the top. The gas, which is a by-product of the digestion process, was discharged into the air and frequently resulted in odours in the vicinity of the plant. Finally, perhaps first at Birmingham, England, there was developed the "separate sludge digestion" process, which simply meant that instead of trying to carry out the two functions of settling and digestion in the same tank, a separate tank was provided for each step. This was a material improvement, as it eliminated from the settling tank the disturbance of quiescent settling due to uprising gas bubbles and it allowed manipulation of the digestion tank's contents to produce more definitely satisfactory results. This type of tank was also less costly to build as it could be made relatively shallow and placed above ground if necessary.

The Digestion Process

Studies on this type of tank and the basic reactions that went on showed that they had the same tendency to foam and create odour that the earlier types had. A study of the bacterial reactions indicated that this was caused only when acid conditions existed in the decomposing mass in the tanks. Experiments with reagents changing the mass to an alkaline condition gave an immediate improvement in the operation, no foaming, no odours and the production of a large volume of gas. In the acid stage of decomposition gas is produced but it is highly charged with hydrogen sulphide which has an offensive odour. The gas produced by the alkaline digestion contains a large quantity of methane and does not have a disagreeable odour. In fact it has so little odour that in Germany, when sewage gas is utilized, the law requires the addition of mercaptans to add odour to facilitate the detection of an escape of gas.

A small scale plant using this separate system was built at Rochester, N.Y., in 1921 and there the advantages of the alkaline digestion were developed. It was noticed, as had been the experience elsewhere, that in the cold months the sludge digestion tanks acted as storage tanks and very little bacterial action went on until the tank contents warmed up in the spring. This led to the belief that if the tank contents could be heated the destructive action of the bacteria could be maintained throughout the year, and therefore if the digestion process could be made continuous tank sizes could be reduced and plant cost cut down. However, the expense of heating large tanks, sometimes reaching 100 feet in diameter and 30 feet deep, seemed an insurmountable obstacle until it was found that the natural process of digestion produced a very appreciable amount of combustible gas. Observation of the amount of this gas showed that it was sufficient to provide all the heat needed to heat the tanks under all climatic conditions. Further observation showed that this gas runs normally about 74 per cent methane and consequently has a heat value of over 600 B.t.u. per cubic foot, and operating conditions have since shown that the production of this gas, when the tanks are kept heated, is sufficient not only to maintain the heat required in the tanks but also to provide a source of power. Checks on operating plants have shown an average of gas production of one cubic foot per capita per day when heated digesters are used.

The best temperature at which to maintain a rapid digestion cycle is between 80 and 90 degrees F. Experiments have been made at 120 degrees F. and higher ("thermophilic" digestion), but due to the difficulties of maintaining this temperature, the caking qualities of the sludge on heating coils and the fact that if the temperature fails the bacteria which work best at the thermophilic range do not live in the lower ranges, it is difficult to assure continuous action. The result of this work on heated, closed and entirely separate digestion tanks has been so successful that few plants now are built without them and the boards of health of various states have allowed material reductions in the sizes of digestion tanks required.

Fig. 2—Activated Sludge Plant, Guelph, Ontario.

Another development of the digestion cycle was the feeling that there must be some means of causing contact between the digesting masses of organic solids in the digestion tank and the mass of fresh solids being added daily. This was first done by means of a rotating mechanism which stirred the bottom sludge and broke down the scum which collected at the surface, and numerous tanks are in operation using this type of digester mechanism. Later types consisted of a rapidly moving propeller at the top of the tank to keep the tank contents in motion; other means have been the provision of a pump outside the tank to pump the sludge from the bottom of the digester to the top. It is now recognized that some means of maintaining this intimate contact between the actively digesting mass and the fresh mass is essential.

A recent development embodies the two-stage principle of digestion, that is, a series of two tanks, the first equipped for high speed agitation for the purpose of breaking down the solids rapidly, with the result that 90 per cent of the total possible gas is produced in from ten to twelve days instead of the normal twenty to thirty days by the single tank method. After this initial high speed phase the sludge automatically passes to the second or finishing stage in a tank in which there is no agitation, but which is provided with a gas holder which collects the gas produced in both the first and second or completion stage. The effect of this system is to reduce the size of the tanks, thus cutting the cost of the plant, and to provide a larger volume of gas which may be used for power generation.

Utilization of Gas

Reference has been made to the use of the gas derived from sewage sludge as a means of providing heat for the digesters. Early work on this showed that there was always an excess of gas over and above that needed for heat and that a considerable quantity was being wasted. Consequently studies were made of the feasibility of its use for power production. The first attempts along this line were to use the ordinary type of gasoline engine but this was not found satisfactory. Sewage gas is a high temperature gas and contains some hydrogen sulphide so that the valves of an engine of the automobile type will not stand up. The most satisfactory type of engine is that built for use with natural gas, the nearest to sewage gas in its general constituents, and a number of these have been operating with success in this country. The gas from the digester, or from the gasometer, is conducted to the intake of the gas engine, with or without scrubbing. The cooling water from the engine after passing through an exhaust heater is used as circulating water in the heating coils of the digester and contains sufficient heat for the maintenance of satisfactory digestion. It has been found that from 15 to 20 cubic feet of sewage gas, depending upon the B.t.u. value and the type of engine, will produce one horse power hour, and when it is considered that the production of gas is averaging one cubic foot per capita per day it can readily be computed that for every twenty of the population connected to a sewage plant, an output of one horse power hour of electrical current is possible.

Where electric current is costly the development of power from gas reduces the cost of plant operation and many of the modern plants are employing the gas in this way. In Germany and England the author saw a number of plants which had been employing gas for power for long periods, and although the types of engines used varied the average results were very much the same.

In several cases, where electrical energy is cheap, it has been found expedient to purchase current and to sell the gas to the local gas company for mixing with their supply. In this way a revenue is provided which will offset some of the operating costs of the plant. As sewage gas averages 650 B.t.u. per cubic foot and the illuminating gas generally supplied by a utility company averages 525 B.t.u. per cubic foot, it is evident that the sale of gas should be on a basis of B.t.u. value rather than so much per cubic foot. The city of Baltimore, for example, is arranging to sell its gas to the local gas company and several other large cities are also considering similar propositions. In Germany it is often sold to gas companies while in one plant the gas is bottled in cylinders under pressure and sold to small users.

Secondary Treatment of Effluent

The final treatment of the liquid effluent is the factor which affects public health to the greatest extent. The handling of the sludge has always been the most troublesome end of the work but in general this does not affect the health of adjoining communities; it is more apt to be a source of nuisance to the plant operators and the citizens of the locality in which the plant is located. The reduction of the constituents of the residual effluent to a condition where they will not cause sludge banks in the stream, or reduce the oxygen content to a point where the stream is rendered useless for recreational or domestic use, is an entirely different phase, and is known as secondary treatment.

Methods of secondary treatment have, like the general elements, run the gamut of wide change and experimentation. The desire has always been to achieve the required results with the minimum of time and space requirements. The increasing knowledge of bacteriology and biological processes and the use of chemicals has changed this picture materially from the old basis. In the early days it was found that the oxidation, which is the step required to stabilize the organic solids in solution to a point where they will not further decompose or deplete the oxygen in the stream, could be obtained in several ways which normally combined keeping the sewage in contact with the air and at the same time providing a medium for the culture of aerobic bacterial growths which broke down the organic organisms. Other forms of anaerobic treatment were found effective. The first form employed a bed of sand over which the sewage was allowed to flow and through which it percolated to the underdrain system. The objection to this system, except for very small places, was that the large areas required made it an expensive process. The average allowance for sand filter beds on sewage is 150,000 gallons per acre per day. As that was out of the question for large cities, investigations made on other means of oxidation developed the contact bed, which consists of a concrete tank, perhaps 5 to 6 feet deep, filled with broken stone. The sewage is allowed to fill up to within six inches of the surface of the stone, and lie dormant for two hours, during which period the anaerobic bacteria operate on the organic matter, after which the sewage is released. The average rate of application to this type of filter is around 400,000 gallons per acre per day. This was better but still not good enough for large installations.

Fig. 3—240 m.g.d. Addition to Calumet Activated Sludge Plant, Chicago.

Further experiment led to the development of the aerobic type of filter consisting of a heap of stone 6 to 8 feet deep. The sewage is sprayed over this by fixed sprinkler nozzles or revolving distributors, and allowed to trickle through to the bottom, the aerobic bacteria, clustered in a form of jelly on the stones of the bed, destroying the organic matter as the sewage passes. This form of bed is very effective, and the rates of application are much higher than the other types, the usual maximum allowed by boards of health being 300,000 gallons per day per acre per foot of depth; in other words a bed one acre in extent with an average depth of 6 feet is capable of treating 1,800,000 gallons of sewage per day. This development assisted materially in the building of plants for large cities.

However, when it came to the plants for the largest cities, there was still a need for some method of treatment that would require a still smaller area, in order to be able to locate these plants within a moderate distance of the

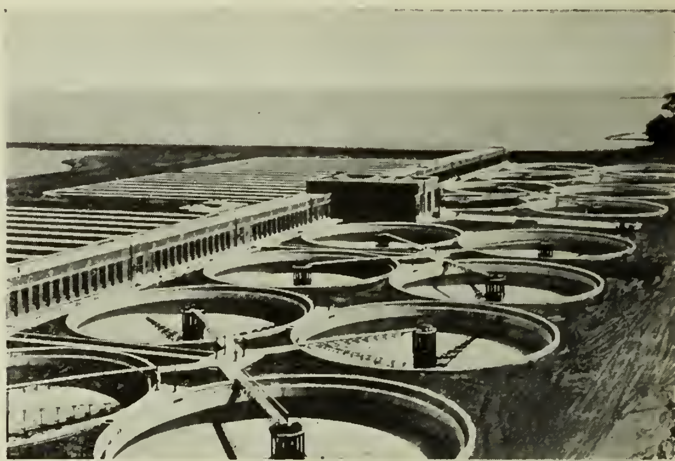

Fig. 4—Activated Sludge Plant for 123 m.g.d., Cleveland, Ohio.

city at a reasonable cost. Developments begun at the Lawrence Experiment Station in Massachusetts and also carried on in England, demonstrated the possibility of oxidizing by the direct application of oxygen, air being blown through the sewage mass as it passed slowly through the tanks. It was found that if this operation could be carried on in the presence of active bacteria that still more successful results were obtained. This became known as the "activated sludge" method and until recently has been the method generally used for the largest cities, enabling them to construct plants of large capacity, in many cases within the city boundaries, as for example in Milwaukee, Chicago, New York.

For some years it has been known that there was a need for some flexible method of treatment between the mere removal of coarse solids followed by sedimentation, and complete treatment by one of the accepted methods of oxidation. The oxidation processes are not flexible and when operated to their highest degree of efficiency produce an effluent which in many cases is of a better quality than needed, and when these processes are not operated as they should be, the results are poor. As every degree of refinement in treatment costs money, the system which will allow an adjustment of the degree of treatment to meet the needs of the case, will provide sufficient relief in many cases; and if this treatment may be increased in efficiency at will it is so much the better. In order to obtain this, much work has been done, especially in the past five years, on the addition of chemicals, in combination with some of the other methods, to achieve a greater removal of solids, both suspended and dissolved, and produce an effluent which would be suitable in a great majority of the cases for discharge into a stream. This has led to the development of several methods, some of them proprietary and some a combination of accepted known methods. Several of these methods have shown the possibility of building a plant in which the efficiency may be regulated to suit seasonal conditions, and which will be adjustable to varying loads or sudden influxes of solids. Most of them embody the use of several chemicals to precipitate the solids and additional chemicals to facilitate the dewatering and rapid handling of the sludge. There is not space to discuss all of these methods, but at the present time several plants of one type are in operation at Dearborn, Michigan, a large scale demonstration has been made at Chicago on another, and a still larger experiment at Atlanta on a third. A full scale plant at Birmingham, Alabama, has been in operation since early this year employing a combination of chemical precipitation with biological processes with an extremely satisfactory result. This plant employs only one chemical and has been able to show very high removals of suspended solids, total bacteria and reduction of biochemical oxygen demand at an expense averaging less than $6.00 per million gallons, omitting interest on investment and amortization of principal. This plant is so flexible that it may be operated in any one of six different ways to obtain varying results as the seasonal demands require. New York city is about ready to take bids on the first units of a chemical precipitation plant which will have an ultimate capacity of 140 million gallons per day which will utilize chemical precipitation in the summer and primary treatment in the winter months. The main objective in these studies is to reduce the initial plant cost and the operating costs. Practically every one of these chemical processes will reduce the first cost, but in some the cost of operation, due to the complexity of chemical dosage, runs higher than in some of the older oxidation processes.

Disposal of the Sludge

Sludge, which is the solid residue from any type of plant, is the greatest problem of all. This material, running in volume from approximately 1,800 gallons per day for primary treatment, with a moisture content of 94 per cent, to 15,000 gallons per day for activated sludge plants with a moisture of 98 per cent, presents a problem because of its tendency to decompose and cause odours. Digestion of these sludges, with control of the *pH* value and temperature can be effected satisfactorily, but as the ultimate residue of the digestion is a mass of relatively inert but wet material averaging 50 per cent of the original mass, there is still the problem of final disposal. Much thought has been given

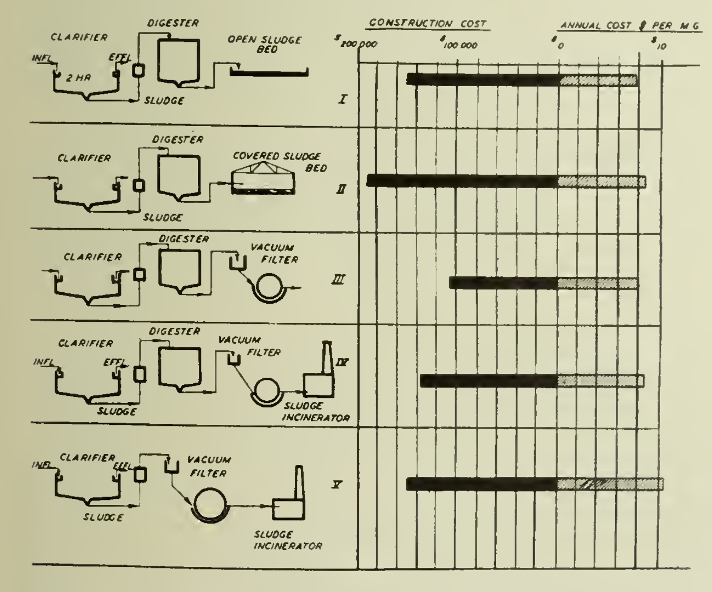

Fig. 5—Relative Cost of Primary Treatments of Sludge Disposal for Plant of 10 m.g.d. Capacity.

to a further reduction in the moisture content of the digested sludge and this has led to the employment of the vacuum type of filter. This filter, which has been used in the metallurgical and other fields, provides a rapid means of withdrawing the moisture from mixtures of solids and liquids by a high vacuum and delivering the material in the form of a cake. For digested sludge these units have proved their ability to handle the material in a small area and at a low cost, delivering a sludge of around 75 per cent moisture which is in a suitable condition to be hauled away and used as a fertilizer. In some of the activated sludge plants the wet sludge has been applied to the vacuum filters direct but subsequent drying by heat has been found necessary to put the sludge in a condition for final disposal. The digestion of the activated sludge excess combined with the raw sludge from the primary settling tanks has proved to be an economical step, reducing the amount of material to be filtered and consequently reducing the amount of conditioning chemical to be added to the sludge. A further step has been recently developed

Fig. 6—Fine Screening Plant, Los Angeles, Calif.

at Baltimore, in experiments with "elutriation" or washing of the sludge to remove from it some of the fine particles. This has resulted in increased capacities of filters, with a higher rate of application, a reduced chemical dosage and consequently a lowered cost all around, all leading in the end to complete plants in a small space at less cost.

The earliest method of disposing of sewage sludge was to discharge it into lagoons where it dried as it could. This was a noisome operation and soon reached its limit. The next step was the discharge of the sludge on to sand drying-beds, but here the sludge was subject to the weather and dried irregularly. These beds ordinarily occupied a space of one square foot per capita served, which in a large plant meant a large area. To overcome this difficulty and provide a bed that would not be delayed by wet weather, glass covers of the greenhouse type have been adopted in recent years. This allowed these beds to be built on the basis of one-half square foot per capita, but this halving of the size did not halve the cost, as the extra cost of the covered bed more than made up the difference. However, by retaining the sludge under cover it was found that the beds could be located closer to built-up districts, and the people did not seem to object to them, perhaps for the reason that a greenhouse being associated with flowers and pleasant smells made them forget that sewage had any odour.

The relative costs for construction and operation of five methods of sludge disposal are shown in Fig. 5.

The extent to which sewage treatment should be carried is, as previously stated, a matter for serious study with a knowledge of all conditions, and consideration will now be given to the various accepted methods and the results that may be anticipated.

The removal of coarse solids by bar screens is not considered a method in itself, but is usually the primary element in all plants. With bars spaced one inch apart a bar screen may be expected to remove between 2 and 4 cubic feet of material per million gallons of sewage. If equipped with mechanical means for removing the solids caught on the bars and with provision for operating the cleaning mechanism when accumulations have been built up on the bars, screen operation is simple and fool proof.

Where the removal of visible solids is the main consideration, fine screens should be used. A fine screen is a revolving drum or a rotating disc covered with plates which have openings or slots in them ranging in width from $\frac{1}{16}$ to

¾ of an inch depending on the amount of material to be removed. Figure 6 shows a fine-screening plant at Los Angeles, California, having a capacity of 150 million gallons per day and using five screens 14 feet in diameter by 12 feet long, with $\frac{1}{16}$ inch by 2 inch slots. The fine screen recognizes size alone and will not remove very fine solids or solids in solution. It cannot be considered a complete treatment and removes normally between 10 and 15 per cent of the total suspended solids in the sewage. These solids may be incinerated and disposed of with little effort.

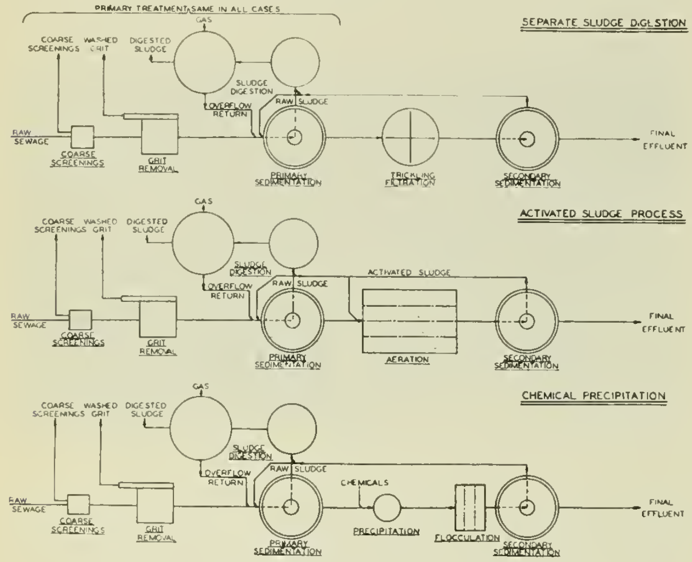

Fig. 7—Typical Sewage Treatment Flow Sheets.

Where a higher removal of the finer solids is required it is common practice to utilize sedimentation tanks, with from one hour minimum time of detention to four hours maximum, an average of two hours being accepted by most engineers as satisfactory. An efficient modern sedimentation tank will remove from 60 to 70 per cent of the total suspended solids in two hours when equipped with modern methods for collecting and removing the sludge so that the volume of the tank is always maintained at its maximum.

Treatment Varies With Requirements

In many places a bar screen and a sedimentation unit will accomplish the desired result at a moderate cost. Chemical precipitation may be applied to the sedimentation unit and this will increase the percentage of removal to 90 per cent or more, thus making this method applicable to a great majority of cases.

Where a high degree of purity is required for effluents to be discharged into streams used as the source of potable supplies for other cities, one of the accepted methods of oxidation may be employed, such as trickling filters, either of the fixed nozzle or revolving distributor type, or activated sludge.

The various combinations that may be made are shown diagrammatically in Fig. 7, while Fig. 8 shows the comparative results to be obtained, from the standpoint of removal of suspended solids, together with the relative initial cost per million gallons of treatment for plants averaging 10 million gallons per day (the sewage of about 100,000 people), also the amount of land required.

In the author's opinion the work done by sewage plants should be the criterion of cost of treatment. For instance, a fine screening plant, which will remove 15 per cent of the suspended solids and costs approximately $10,000 per million gallons for installation shows a cost per part per million removed of $666 whereas a plant comprising sedimentation and sludge digestion for the same volume, which will cost $30,000 per million gallons and will remove say 60 per cent of the suspended solids shows a cost per part per million removed of $500. As the percentage of removal of solids is the index of completeness of any given method it would seem logical that the method which removed the highest percentage of these solids at the lowest cost per part per million removed is the most economical system to adopt. In any given case these questions must be decided on their individual merits and with due regard to all local conditions.

Today the modern sewage treatment plant consists of a series of mechanical units so related to each other that the functions are performed continuously and with the least manual attention. The adoption of mechanical units has made efficiency of plant operation an essential. To instill in the minds of the plant operator the importance of his job the various sewage works associations in the United States, England and Canada all have as their basic object the encouragement of the operator to have pride in his plant, and make it operate as it was designed to do.

In the older plants the idea was that as sewage was an outcast product, the only place to put the plant was as far away from the residents of the town producing it as possible, and there was a concurrent idea that "sewage must smell" so why worry about it if the plant was odorous. It is now realized that this idea was wrong, as with the advancement of modern methods sewage is as much a matter of municipal concern as water supply, garbage collection or other municipal activity and must be handled in a manner to give the least offence. The improvement in the architectural design of the sewage plant, and the development of methods of treatment to the point where plants may be odourless, have made it possible to place the plants in the most suitable location, namely where the sewage drains best by gravity, whether that be in the centre of the city or on the outskirts. That this has been done successfully is evidenced by the illustrations of some of the modern plants reproduced in this paper.

Sewage treatment must be looked on as a science. When a city is faced with a problem involving so much in the way of municipal economy, continuity of efficiency and the maintenance of public health, the best interests of its own citizens and its neighbours justify thorough investigation and the employment of the best advice. The object is to provide the most suitable plant for the conditions, at the least cost consistent with modern construction and complete usefulness to the end of the period of expected life of the structures.

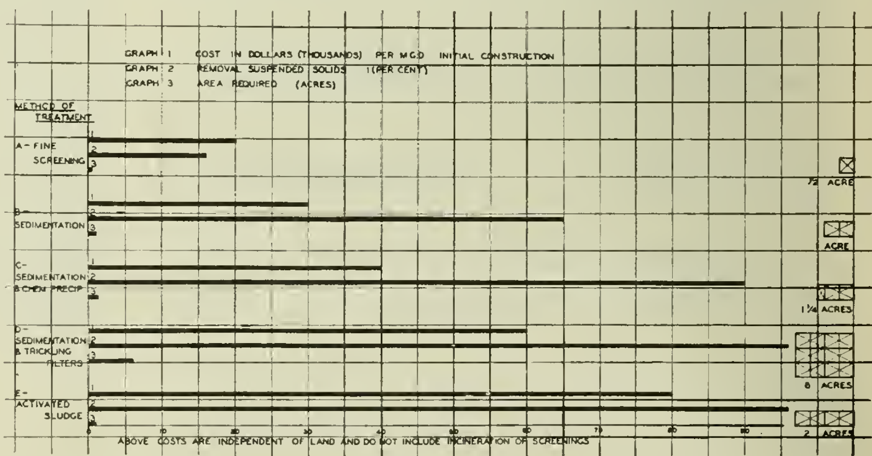

Fig. 8—Degrees of Sewage Treatment with Cost and Area Required.

Testing of Aircraft Fuels

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Paper presented before the Ottawa Branch of The Engineering Institute of Canada.

SUMMARY—The quality of gasoline for aircraft use is determined by tests for colour, gum, sulphur, vapour lock and freezing point, as well as by fractional distillation, which gives its characteristics as regards starting, acceleration, distribution and crank-case dilution. These tests are described and the paper concludes with a discussion of knock-testing and the determination of the octane number of a given fuel.

It is the intention of this paper to describe the various tests which are imposed on fuels to prove them satisfactory for use in aircraft engines. Perhaps the most important question is not how the test is conducted, but rather why it is done. If this is not kept in view, the test then becomes purely routine.

The tests which are carried out are of two general classifications: (*a*) laboratory tests; (*b*) road or service tests. The laboratory tests include development and routine work, while the service tests give what might be termed "full scale" results, showing the effect on the actual operation of the engine for which the fuel is intended.

Fuel specifications are as numerous as the wide range of uses for which gasoline is employed. Some operators insist on writing their own specification; others are content to use an existing specification, while others will use almost any fuel which will run through a feed line and burn.

Unless all factors are taken into consideration, a specification for fuel does not serve its purpose. For example, suppose the operator of low compression engines insists on the same quality of anti-knock fuel as that which is intended for high compression or supercharged engines, the cost will be considerably higher than that of a fuel which will successfully suppress detonation in his engine, and no particular gain is made, but detonation must be suppressed or else serious damage to the engine will result.

To be satisfactory, specifications must suit the purpose for which they are written, and anything more than a safe tolerance is imposing a restriction on the refiner who must charge for it. Specifications must vary to suit the wide range of uses for fuel, but the less variation there is, the more economical they will be.

Fuel specifications usually start off with a general clause which is self-evident, stating that the fuel shall be free from impurities and may insist that it consist of a straight run gasoline. This is because the fuel is not intended for immediate use, and cracked gasolines do not stand storage as well as do straight run gasolines.

Colour

Colour for identification is generally specified to be of a certain depth. This depth is usually determined by a chromometer.

The Saybolt chromometer consists of two glass tubes about 20 inches in length and 14-16 mm. inside diameter, held in a vertical position. The lefthand tube is of plain glass and is open at both ends. At the bottom of this tube is a collar for holding one or more glass slides. The other tube is calibrated and is closed at the bottom with a colourless plate. Below the tubes is a mirror to reflect the light through them into the optical prism eye piece at the top. The field appears as two halves of a circle, one half having the colour of the glass discs and the other the colour of the fuel or oil in the calibrated tube.

It should be stipulated that the colouring material used be such that no ill effects may be experienced by clogging the carburettor jets, etc.

Apart from tinting the fuel for identification, colour indicates very little to the average operator. Of the clear gasolines, some remain clear for long periods, while others turn quite yellow in a short time. Most of the cracked gasolines fall into this latter group. A negligible sulphur content will help to give a yellowish tinge to the fuel, or the colour change may indicate the presence of gum.

A change in colour does not necessarily mean that the fuel is not good, but there is a certain hesitancy on the part of consumers to buy a fuel that is neither crystal clear nor highly coloured. Taking advantage of the present demand for coloured gasolines helps to solve this problem.

To test the fuel's resistance to colour change, it is placed in a bottle containing oxygen and kept at a moderately elevated temperature. Change in colour is thus greatly accelerated, and the length of time that it retains its clarity gives an indication as to its resistance to colour change.

Gum

Gum is a resin-like substance which can easily cause serious trouble in an engine. As fuel containing gum is sprayed on a heated metal surface, the gum comes out of suspension and is deposited on this surface. As it is deposited, it is still soluble in gasoline, but when baked to a hard varnish-like residue, it is no longer soluble in gasoline and must be dissolved with either acetone or chloroform.

It may easily be imagined what the effect of this gum would be on the operation of an engine. Cracked gasolines are the worst offenders. This is mainly due to the unsaturated hydrocarbons which are present. Gum formation from these unstable hydrocarbons is essentially an oxidation process. Gum will not be formed in the entire absence of oxygen. Natural gasolines seldom, if ever, produce gum.

There are two main types of tests for gum: (*a*) a test to determine the suitability of the fuel for use at the time of testing; (*b*) an accelerated ageing test to ensure that the fuel will not form excessive gum in storage.

Several variations of the first group are in common use. Essentially, they consist of evaporating a small amount of fuel (about 100 cc.) in a copper, iron, glass or porcelain dish, and weighing the residue. The container is generally placed in a steam bath and some methods call for an air jet to play on the surface of the fuel. A good deal of confusion results when an attempt is made to interpret results of tests conducted under one set of conditions in terms of tests under different methods. A tentative standard method has been adopted(1) for a gum test in which fuel is placed in a glass beaker and evaporated in a constant temperature bath at 320 to 330 degrees F. Heated air is blown over the surface of the fuel during evaporation.

For automobile requirements, less than 10 to 15 mg. of gum would indicate that the fuel is satisfactory for use. For aircraft this figure should be reduced considerably; three mg. often being used as the limit.

Accelerated Ageing Test

The apparatus (shown in Fig. 1) consists of a bomb into which an uncorked bottle of gasoline is placed. The bomb is then closed and oxygen forced into it at a pressure of 100 pounds per square inch. The bomb is then placed in boiling water and the pressure increases to a constant value. Unless the bomb is leaking, this pressure will remain constant for a certain period. This period, which is called the induction period, will vary, depending on the fuel.

(1) American Society for Testing Materials (D 381-34T).

It is generally agreed that a fuel which will stand the four-hour induction period without dropping pressure will stand long periods of storage; but whether or not the test is too severe for those fuels which do not pass this test is still an open question.

A third phase in the gum problem is the correlation between the various laboratory tests and the results of engine tests. Most of this work has been done on single cylinder engines and more information on tests made on multi-cylinder engines would be of material help.

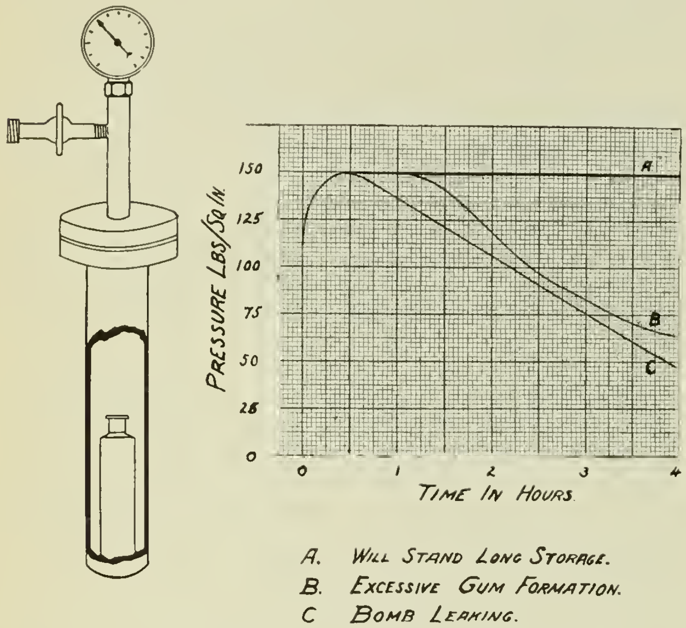

Fig. 1—Oxygen Bomb for Accelerated Ageing Test.

Gum inhibitors are sometimes used, which considerably delay the formation of gum, but this is a subject about which information is still incomplete.

Sulphur

There are two forms of corrosion due to sulphur, one in the fuel system and the other in the crankcase. The former is due to sulphur in the fuel before combustion and the latter due to the products of combustion.

A sulphur content of above 0.1 per cent in a fuel has been known to cause rapid and serious corrosion, especially at wristpins, bearings, and even on cylinder walls. Therefore it is obvious that the sulphur content must be limited, and this is generally set at 0.1 per cent.

To test a fuel for sulphur content, the A.S.T.M. lamp method is generally employed (see Fig. 2). The test consists of burning a known amount of fuel and the absorption and titration of the SO_3 formed.

Vapour Pressure

The property of a fuel which determines its tendency to boil and cause vapour lock, is called vapour pressure. If this occurs in the fuel line of an aircraft or automobile, the engine, because it is receiving insufficient fuel, sputters and stops.

The three fundamental variables in connection with vapour lock are: (*a*) temperature, (*b*) pressure, (*c*) vapour pressure.

With the exception of propane, gases are not usually present in commercial fuels in sufficient quantities to cause vapour lock. Removing this propane robs the fuel of a certain amount of its anti-knock value. A propane content of 1 per cent, which is not uncommon in some fuels, will raise the vapour pressure approximately 2 pounds per square inch.

From tests made at the United States Bureau of Standards(2) the following formula has been developed to give approximately the temperature at which vapour lock may be expected.

$$t = 560\frac{5.167 - \log p_r}{5.167 - \log p} - 460$$

where

t is temperature in degrees F.
p_r is Reid vapour pressure in pounds per square inch
p is atmospheric pressure at the given altitude in pounds per square inch.

In the case of a fuel having a Reid vapour pressure of 8 pounds, vapour lock on the ground might be expected at 130 degrees F. This temperature would be lower as the plane rises. Proper design of the fuel system will materially aid in avoiding vapour lock.

The Reid vapour pressure is determined by means of a Reid vapour pressure bomb (Fig. 3), which consists of two chambers, one above the other, with a pressure gauge at the top. The upper and larger chamber is for air, and the lower for gasoline, all three sections being connected internally.

The fuel chamber is purified and then filled by immersion in gasoline. The temperature of the air chamber having been taken and noted, the fuel chamber is then screwed on and the whole bomb immersed in a constant temperature bath and kept at 100 degrees F. Occasionally, it is taken out and shaken vigorously to permit the fuel to pass into the larger chamber where it comes in contact with the heated air. It is then put back in the bath. This is repeated until the pressure stops rising. The maximum pressure is noted and correction made for the original temperature of the air chamber; the net result being the Reid vapour pressure in pounds per square inch.

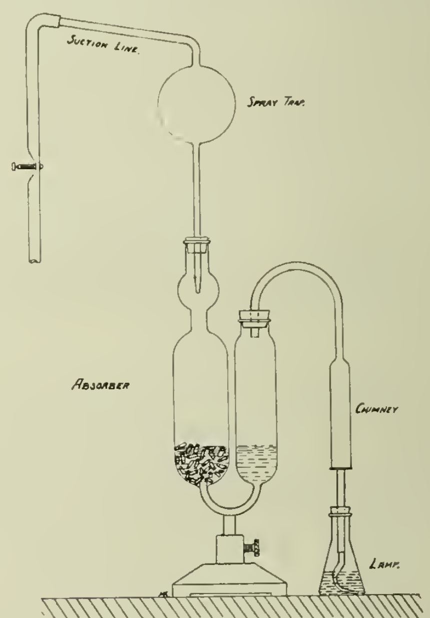

Fig. 2—A.S.T.M. Sulphur Lamp Apparatus.

Distillation Range

The distillation curve of a fuel gives a very good indication as to how that fuel will act in an engine as regards starting, acceleration, distribution and crankcase dilution. These points may be more fully understood from a description of the test procedure.

Figure 4 shows the A.S.T.M. distillation apparatus. 100 cc. of fuel are measured into the graduate and trans-

(2) See Properties of Gasolines with reference to Vapour Lock, Bridgeman and Aldrich, S.A.E. Journal, July 1930, page 93.

ferred directly to the Engler flask which is mounted on a stand immediately above a Bunsen burner. Around the flask and burner is a metal shield. The vapour outlet tube from the flask is connected to a condenser which in turn is set in a bath of ice and water or other cooling medium. The outlet of the condenser is placed in the mouth of the same graduate which was used to fill the flask, and a cover slipped over the top. Heat is applied to the flask at a specified rate. The temperature at which the first drop falls from the condenser tube is taken as the initial boiling point. Temperatures are also taken as the level of the distillate reaches each 10 cc. mark in the graduated receiver. The end point or maximum temperature is the highest temperature observed on the thermometer. This point is usually reached after the bottom of the flask has become dry.

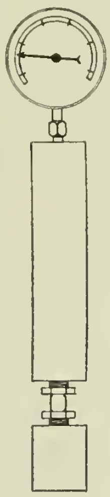

Fig. 3

The recovery is taken as the total volume of distillate as collected in the graduate. The residue is the volume of condensed vapour left in the Engler flask. The distillation loss is the difference between 100 cc. and the sum of the residue and the recovery.

When these 10 cc. points are plotted on a temperature-volume basis, the result is the distillation curve for that fuel (Fig. 5). The ideal fuel is one whose boiling point is sufficiently high to avoid vapour lock and fire hazard, but which will have a more complete removal of the hump in the distillation curve.

Starting characteristics are dependent upon the temperature at which the first 5 to 10 cc. are distilled. If this temperature is too high, starting will be impossible. If this temperature is too low, vapour lock may be expected. Heavier fuels are slightly more economical, but these cause hard starting and tend to crankcase dilution. Starting should not become impossible unless the initial boiling point is more than 140 degrees F. below the 10 per cent point. Ease of acceleration generally depends upon the slope of the curve between the 30 to 70 per cent points.

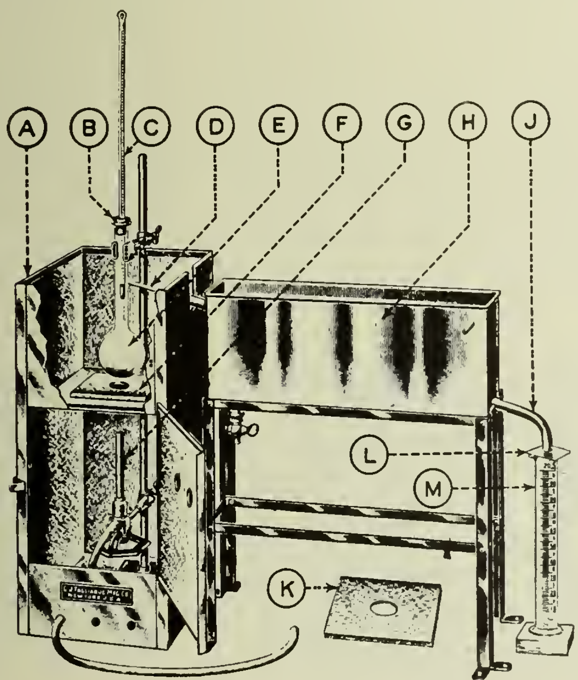

Fig. 4—A.S.T.M. Distillation Apparatus.

Distribution in an engine relates to the percentage of fuel which is evaporated in the manifold. Since the temperature of the engine from "all cold" until it warms up varies considerably the significant part of the curve varies from the 10 to 90 per cent points.

Various tests show that crankcase dilution is determined by the temperature of the 90 per cent point. The higher the temperature at this point, the greater the dilution that may be expected. The 90 per cent point is also an indication of the maximum temperature to which fuel should be heated in the manifold.

The initial boiling point has no bearing on the volatility of the fuel as a whole.

Freezing Point, Acid Heat and Specific Gravity

The main reason for the freezing point test is, of course, to ensure that the fuel will not freeze at the low temperatures that may be encountered in service, but it also shows whether or not there is much benzene in the fuel. The temperature of the fuel is gradually lowered and the point of initial formation of solid matter is taken as the freezing point.

Acid Heat

The acid heat test is conducted to determine whether or not there are present in the fuel unsaturated hydrocarbons in sufficient quantities to cause trouble, as these unsaturateds are apt to form gum in storage.

About 150 cc. of the fuel are placed in a thermos flask with 30 cc. of sulphuric acid, and shaken. This mixes the two thoroughly.

If there are unsaturated hydrocarbons present, the temperature will rise. Other impurities will also tend to raise the temperature.

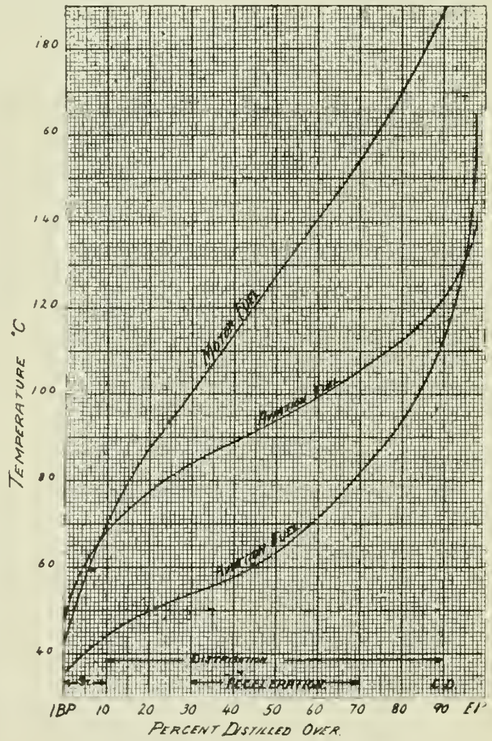

Fig. 5—Distillation Curves.

For aircraft fuels this temperature rise is limited to 20 degrees F.

Specific gravity used to be taken as one of the main considerations in selecting a fuel, but little importance is attached to it at the present. Most specifications disregard it completely. The test is made with a hydrometer or with a weighing bottle.

Acidity

The acidity test is made to ensure that no acids are present in sufficient quantities to cause damage in an engine. The fuel is well shaken with water, and the presence of acid determined with an indicator. Methyl orange is often used as the indicator, the methyl orange changing colour in the presence of acids.

Corrosion may be caused by acidity or excess sulphur in the fuel. If the fuel corrodes engine parts it may be very serious and for this reason a corrosion test is made.

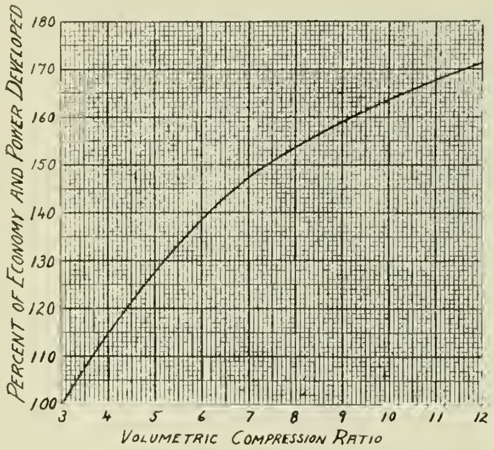

Fig. 6—Effect of Compression Ratio on Operation.

If the copper dish method is used for the actual gum determination, as described earlier in the paper, the dish may be examined after evaporation is completed and the two tests thus combined. The test consists of evaporating a small quantity of fuel in a polished copper dish. There should be no grey or black corrosion of the dish. An alternative test is to place a freshly polished strip of copper in a test tube with gasoline. The test tube is placed in a bath and kept at 122 degrees F. for three hours. Discolouration of the copper strip indicates corrosion.

Anti-Knock Value or Octane Number

When a combustible mixture is ignited, the flame, under normal conditions, tends to travel from the point of ignition at a definite velocity. Should the pressure in an engine show instantaneous instead of gradual rise before ignition is complete, accompanied by a metallic "pinking" and temperature rise, detonation is said to occur. This knocking or pinking is due to high period vibration and is not at all regular. If detonation is permitted to continue, it is apt to increase in intensity and in severe cases, pass over into pre-ignition.

The chief difference between pre-ignition and detonation is that pre-ignition involves a large part, or the whole of the charge, and is caused by faulty ignition timing or spontaneous combustion. With detonation there are present only vibration, roughness and higher temperatures. While there is a good deal of difference, in theory, between detonation and pre-ignition, in practice it is sometimes impossible to tell whether an engine is pre-igniting or detonating.

A poor air-fuel ratio will reduce detonation, but this of course is not a solution. Heat accentuates the tendency of a fuel towards detonation. Change in the design of the combustion chamber and location of the spark plugs may also reduce detonation.

The chief fuel factors which influence detonation are:

(*a*) Composition of the fuel. Some of the hydrocarbons are very apt to knock at low compression ratios, while others resist detonation. The paraffin group show the greatest tendency towards detonation while the aromatics show the least, though there are exceptions. The highest useful compression ratio (H.U.C.R.) or compression ratio determined on a variable compression engine at which power increase stops, has been found for many of these hydrocarbons, a few of which are given below.

N heptane	2.75 to 1
N pentane	3.8 to 1
Iso-octane	6.9 to 1
Benzene (above)	15.0 to 1
Toluene	13.6 to 1
Cyclo hexane	4.5 to 1
Absolute ethyl alcohol	11.6 to 1

(*b*) The stability of the mixture at the induction pipe temperature.

(*c*) The mixture or air fuel ratio.

A compression ratio low enough to resist detonation in all fuels in use would give very poor engine performance as regards power and economy, as is shown in the curves in Figs. 6 to 9 which have been plotted from tests made at various compression ratios and show the marked improvement resulting from an increase in compression ratio from 5.2:1 up to 7.0:1. Increasing the compression ratio definitely increases the power of an engine providing detonation is suppressed; and the inertia loads are actually decreased.

Figures 10 and 11 show the effect of an increase in the compression ratio upon wheel torque and gasoline consumption in an automobile.

Carbon deposits cause a big problem for high compression engines by seizing the piston rings in their grooves and by filling the combustion space, thus increasing the compression ratio, but this can be partly overcome with a carbon solvent.

The reason for this detonation phenomenon has been the subject of close study and the cause of a great deal of controversy ever since the end of the great war, when the octane number of commercial gasoline in England was about 35 in some cases. It is not intended to convey the impression that all combustion study started at that time. A lot of work had been done previous to this, but perhaps without the same object in view.

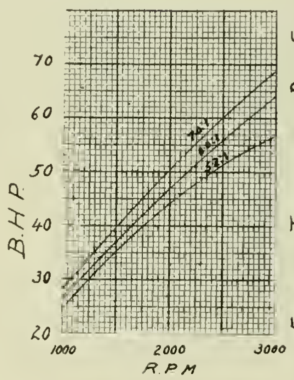

Fig. 7

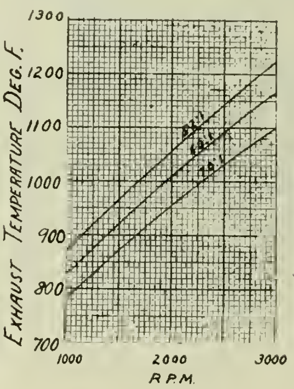

Fig. 8

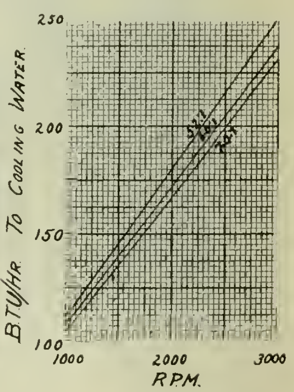

Fig. 9

Effect of Compression Ratio on Operation.

An article by Whatmough appeared in the Automobile Engineer for November 1927, covering fifteen theories which had been advanced to explain detonation. Even at the present time, it is generally conceded that a complete explanation of this phenomenon has not yet been found, and although some very reasonable assumptions are made, they do not satisfy all cases.

What is probably the clearest account, is that put forward by the late Professor Callendar of the Royal College of Science, London.[3] His explanation of the phenomenon is that organic peroxides are formed and these are known to explode violently. In some cases these peroxides have been found, though not in all. He also stated that microscopic drops consisting of the less volatile hydrocarbons, act as foci of ignition as their ignition point is lower than that of the vapour. The process seems to be a chain reaction in which the energy that starts the initial reaction releases other energy sufficient to start other reactions, and so on.

To bear out the peroxide theory, tests were made to find a relation between the substances which formed these peroxides, and those which did not. The results are as follows:

(*a*) Substances which showed peroxide formations.
- Amyl and ethyl ether
- Paraffin hydrocarbons (pentane to undecane)
- Turpentine
- Paraffin oil
- Paraldehyde
- Propyl aldehyde

(*b*) Substances showing no peroxide formation, or traces only.
- Ethyl alcohol
- Methyl alcohol
- Amyl alcohol
- Butyl alcohol
- Benzene
- Aniline

(*a*), it will be noted, are pro-knocks, while (*b*) are anti-knocks.

A third group consisting of detonating substances was tested, but no peroxides were found. If the combustion process can be controlled until the combustion of the whole mixture is more advanced, then this reaction will not be so violent. This would seem to show why such a small amount of knock-inhibitor affects the combustion. The knock inhibitor appears to absorb the oxygen that would otherwise form peroxides. Engine speed also affects detonation, by altering the time of the explosion stroke. This is shown in tests carried out in England giving the following results:—

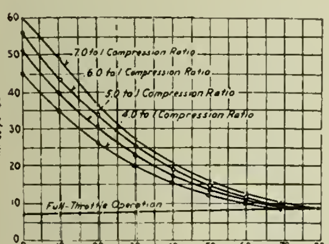

Fig. 10

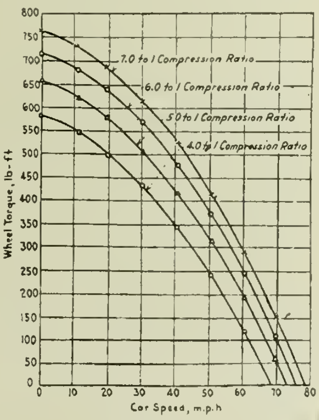

Fig. 11

Effect of Compression Ratio on Operation.

r.p.m.	H.U.C.R.[4]
1,200	4.45:1
1,300	4.65:1
1,400	4.90:1
1,500	4.95:1
1,600	5.00:1

Increase in compression ratio with its attending increase in compression pressure and temperature is the greatest cause of detonation.

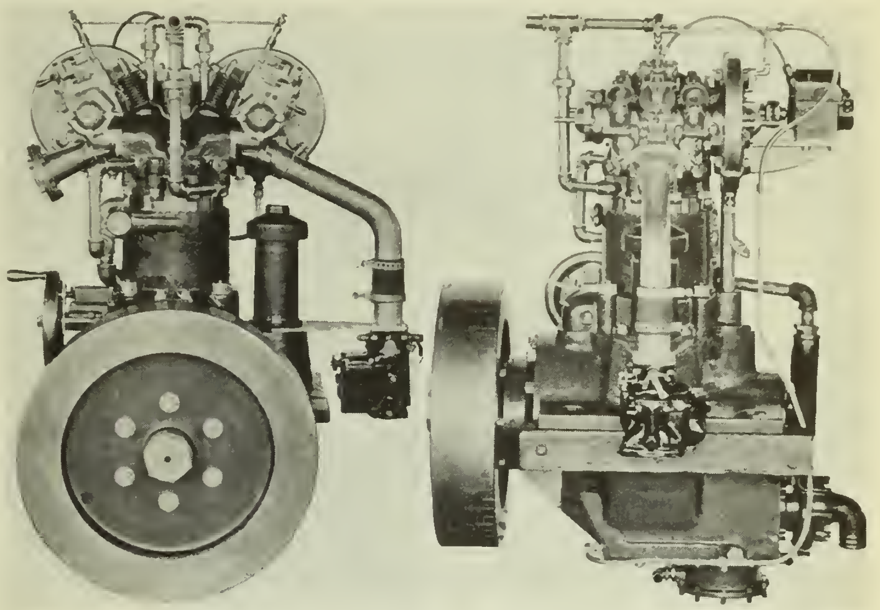

Fig. 12—N.A.C.A. Universal Engine for Testing Fuels.

When this phenomenon was recognized, it became necessary to find some means to control it if engines were to be as efficient as possible. It was found that several substances when added to fuel tended to decrease or to prevent the knock. It was also found that some of these substances were much more effective than others. To date, lead tetraethyl is the most effective knock inhibitor that has been found, and the number of substances tried runs literally into the thousands. Numerous other substances suggest themselves as knock inhibitors, but the main difficulty is to find some form of that substance which is soluble in gasoline and which will not attack the engine parts.

The effect of lead tetraethyl may be better understood when it is known that the engines which are used to test the fuels can detect as little as 1/10 cc. of lead per gallon. The amount present in a combustion chamber is estimated as 4/10,000 of a gramme. Lead has its disadvantages, however, as upon exposure to light or heat, it tends to lose its effectiveness, though this does not usually affect the ordinary consumer. As to its toxic effects, it is undoubtedly an unpleasant substance to handle in its concentrated state, but tests made by the United States Bureau of Mines[5] show that there is no danger to the engine operator in using a fuel containing it.

The response of different fuels to anti-knock substances varies considerably. Cracked gasolines do not respond as readily as do straight run fuels. Because of the wide variation in response to knock inhibitors, it is necessary to have a basic standard to which fuels may be compared.

(3) Report of Aeronautical Research Committee, 1927, page 669.

(4) H.U.C.R. The Highest Useful Compression Ratio. This is the highest ratio at which a given fuel may be used without detonation.

(5) Experimental Studies on the Effect of Ethyl Gasoline and its Combustion Products. Report of U.S. Bureau of Mines, 1927.

The selection of such a standard is not at all an easy matter. Up to a few years ago, practically every laboratory had their own method of reporting knock ratings. Some of these could be duplicated on other scales, but with others there was no connection at all, so that a serious attempt was made to establish standards. To be satisfactory a standard must:

(*a*) Cover the entire range of fuels to be tested.
(*b*) Be chemically pure and stable.
(*c*) Be cheap and easily obtainable.

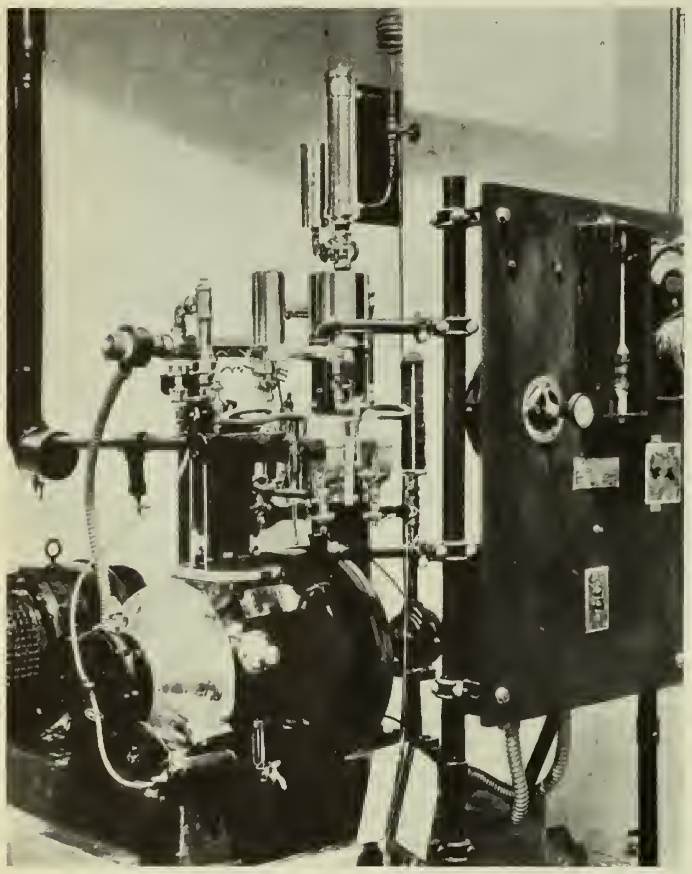

Fig. 13—Ethyl Gasolene Corporation Engine 30B for Testing Fuels.

Obviously, gasoline, which is a complex structure, is not suited for use as a standard.

The choice of hydrocarbons is wide. The result of this movement for standardization was the adoption of a mixture of iso-octane (or 2-2-4 trimethyl pentane), and normal heptane. Unfortunately, the cost of these standards is very high at present, ranging from $20 to $25 per gallon (U.S.).

The term octane number is defined as the percentage by volume of iso-octane (the anti-knock), in a blend of iso-octane and normal heptane (the pro-knock). The higher the octane number, the higher the anti-knock quality. The statement that a fuel has an octane number of 76 means that when tested under certain definite conditions in a specified test engine, the knock intensity of the fuel will be identical with the knock intensity of a mixture of 76 per cent iso-octane and 24 per cent normal heptane when tested on the same engine under the same conditions. In some cases it is admitted that the H.U.C.R. of iso-octane will not be high enough, and benzene may have to be added, but benzene is not satisfactory as a reference fuel, mainly because of its high freezing point.

This term octane number as applied to a fuel means little or nothing unless it is qualified by the engine speed, compression pressure and temperature of the air–fuel charge of the engine on which it was tested. It is an easy matter for a test to be arranged so that a fuel will appear to have an octane number of seven or eight above that which would be allotted to it should it be tested according to more severe test conditions. An endeavour is therefore being made to standardize knock-rating tests. Tests now in general use for various fuels include cooling liquid temperatures of 120, 212, 300, 345, and up to 394 degrees F. while speeds include 600, 750 and 900 r.p.m.

These different knock-testing conditions are however rapidly giving way to the Cooperative Fuel Research Motor Method in the case of automobile fuels, while tests are being conducted with a view towards standardization of test conditions for aero engine fuels.

Knock rating tests do not always agree if they are made on different types of engines, although those made on two engines of the same type agree with surprising regularity; therefore, standardization of engines was the next step. Certain engines, because of satisfactory service, have been standardized in certain localities, but there are still several types of engines in use. Some of these are described to give an idea of the type of engine used for this purpose.

The Ricardo E35 poppet valve, variable compression engine was especially designed for research problems on fuels. The compression ratio varies from 3.7:1 to 7.5:1. The original of this type of engine was built in 1919 and is still in use. The engine has two inlet and three exhaust valves, operated by an overhead cam-shaft. Mixture is controlled by means of a needle valve and a swinging field electric dynamometer is supplied. Fuel consumption is measured by checking the time to use a known amount of fuel. Two fuel systems are used and a three-way cock permits a quick change-over.

The Ricardo E5 engine is of the sleeve valve type produced by the same manufacturer as the above engine. Variable compression is accomplished by lowering or raising the crown of the combustion chamber. Two inlet and two exhaust ports are provided in the valve sleeve, any of which may be blocked to vary the port area.

The Armstrong Whitworth engine was developed by Messrs. Armstrong Whitworth and the Anglo-Persian Oil Company. A variable compression head is fitted, and the variation is accomplished by raising or lowering a plug in the combustion chamber. Tests would seem to show that no excessive collection of exhaust gases remains in this pocket. The cylinder head and cylinder walls have individual cooling. A swinging field dynamometer is provided and intake air may be heated. Flow meters are supplied and air fuel ratios are governed by a needle valve in the jet. The above engines are produced in England, and more used on that side of the Atlantic.

In the United States, other engines have been produced, among which the following are being largely used:

The compression ratio of the N.A.C.A.[(6)] Universal Test Engine Model A shown in Fig. 12 may be altered while the engine is running. This is accomplished in the same manner as used in the Ricardo E35 engine. The cylinder base has a heavy thread cut on it, and a ring with an internal thread is turned by a crank. The compression ratio ranges from 5:1 to 13:1. The valve timing and lift may be altered while the engine is running. The valve lift is varied by changing the position of the fulcrum of the rocker. A single carburettor with two fuel systems is provided. This engine is rated at 35 h.p. with a speed of 1,800 r.p.m. A second type, the model B engine, is supplied without the valve adjustment mechanism, though variable compression is retained.

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(6) National Advisory Committee for Aeronautics.

The Ethyl Gasolene Corporation "Delco" model engine was developed from the Delco lighting plant. The compression ratio is set at 7.5:1 and the density of the charge is governed by the throttle. Speed is controlled by means of a rheostat which applies loading to the generator which is coupled directly to the engine. The carburettor has a fixed jet in which the fuel level is raised or lowered by moving the float chambers. In this way the air fuel ratio may be varied at will.

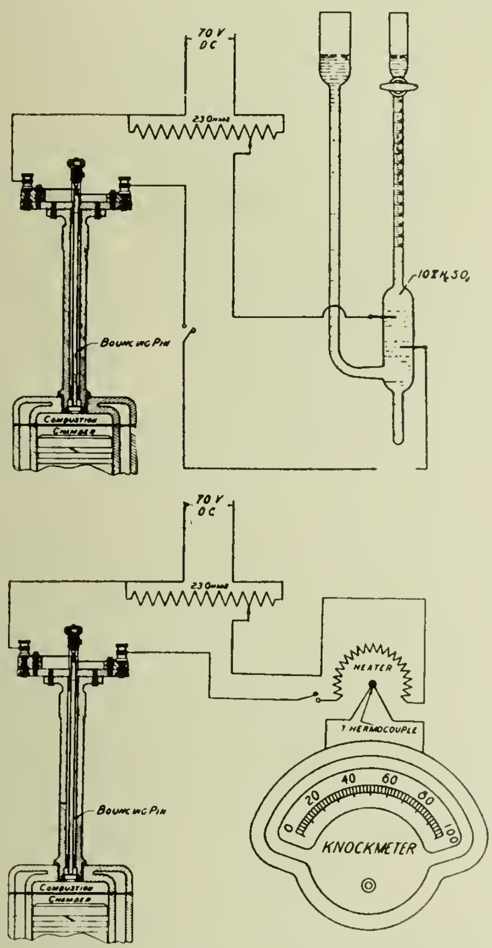

Fig. 14—Apparatus for Measurement of Detonation.

Figure 13 shows the Ethyl Gasolene Corporation Series 30B engine. From experience in the operation of the Delco model, this apparatus was developed. Speed is controlled by a synchronous motor and provision is made for running at higher jacket temperatures. Compression pressure may be adjusted by slipping shims under the cylinder flange. A neon tube ignition indicator is provided. It was for this engine that the "knock meter" was developed.

The Cooperative Fuel Research engine has been developed by the Society of Automotive Engineers and the American Petroleum Institute and has been adopted for use in the United States as a standard engine, and it is considered extremely likely that it will be standardized generally as conditions may warrant.

The usual method for testing the fuel on most of these engines is to compare it to a standard, though knock-testing may be done in several ways. These include the determination of highest useful compression ratio and power loss, and the use of indicator card, aural detection, ballistic device, bouncing pin and thermocouples.

The highest useful compression ratio of a fuel is found in a variable compression engine. This result, unless a standard engine is used, can not always be reproduced on another type of engine, owing to difference in the combustion chamber characteristics. Measuring the power loss is accomplished by measuring the power of a standard fuel and comparing it to the power output of the sample being tested. Indicator cards would be ideal, if there was a satisfactory engine indicator for this purpose, but at present there is no indicator sufficiently accurate and flexible to serve this purpose, especially for routine tests. Aural detection depends too much on the human element, and while good results have been obtained, it is not to be recommended. The ballistic device is much like the Midgely bouncing pin. A plunger rises according to the pressure in the cylinder, and actuates a lever arm. The reading of this instrument, however, depends too much upon the eye of the operator.

The Midgely bouncing pin (Fig. 14) consists of a thin steel diaphragm which forms part of the wall of the combustion chamber. On this diaphragm rests a slender pin which is loosely held in guides. When detonation occurs, the sudden pressure rise causes the diaphragm to deflect and the pin is projected upwards, with a force depending on the intensity of the detonation. As the pin rises, it closes an electrical contact. The greater the force of the pin, the longer the time the contacts will remain closed. The current that passes through these contacts goes either to an electrolytic cell or else to a meter. In the case of an electrolytic cell, it breaks up water in the cell into hydrogen and oxygen. This gas is collected in a calibrated

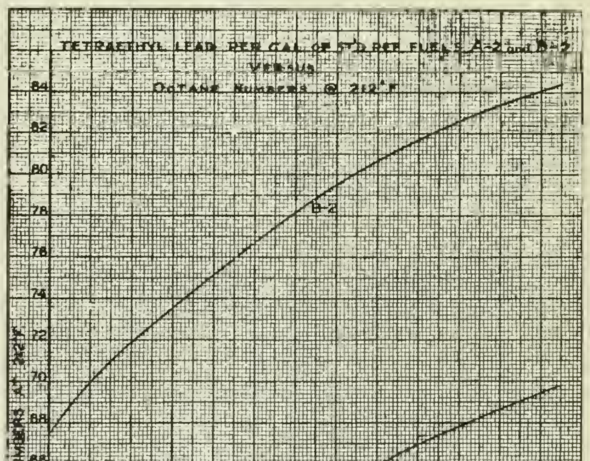

Fig. 15—Reference Fuel Calibration Curves.

tube and the greater the detonation, the more gas formed. Readings are generally taken for a period of one minute. If a meter is used, the readings may be taken directly. Instead of a bouncing pin, a thermocouple is sometimes used and the temperature used in place of pressure.

When work is started on the testing of fuels, the operator needs some practice work to become familiar with all the various details in connection with the operation of the engine and the procedure of the test. These test engines, considering the treatment they necessarily receive, give remarkably good service, but sometimes, in spite of the care that is taken, errors do creep in. These errors are often due to such small causes that it is hard to find them. For example, the engine may be operating with all the variables kept as constant as possible, when suddenly the indicated intensity of the knock will increase or decrease considerably. This is of course taken as a sign that attention is needed in some part of the engine, or in the instruments. Parts which suggest themselves from the character of the trouble are first examined, and if this does not correct it, the whole installation must be gone over.

Perhaps nothing will be found wrong, and the engine is tried again. The faults are quite apt to correct themselves before they are found. Of course, there is a reason for all these variations, but long periods are often spent in trying to locate them. The newer engines are not so liable to such difficulties.

In the knock-testing of fuels, the following is an outline of the method of test as carried out on some types of engines.

There is, in the laboratory, a reference fuel, whose anti-knock value, in terms of octane number, is known. Also, the reaction of this fuel has been tested as lead tetraethyl is added. (Incidentally, this secondary reference fuel is checked periodically against the more costly basic standards.) This fuel, it is remembered, is to be the measure against which the unknown fuel is checked.

To find the octane number of the unknown sample of fuel, it is placed in one fuel system, and the known reference fuel is placed in the other. The engine is first run on one of these fuels, and the air-fuel ratio gradually changed from lean to rich. During this operation, the knock intensity will increase until a maximum is reached, and will then decrease. This air-fuel ratio which produces the maximum knock is the point for which we are looking, and all the others are ignored.

The same procedure is carried out on the other fuel and the maximum knock found for it.

The engine is then run first on one fuel and then on the other alternately, at the air-fuel ratio of maximum knock, until it is determined beyond doubt that the readings obtained are correct, and comparison is made.

Suppose that the reference fuel indicates a knock intensity of 68 on the meter, while the sample only shows an average of 62, it is obvious that the reference fuel requires more lead to reduce its knock. Lead is added, and the procedure again carried out until the two fuels match exactly. Reference is then made to the calibration curves which accompany the secondary reference fuels (see Fig. 15), and the octane number found for that fuel plus the necessary addition of lead. This octane number will also be given to the unknown sample.

For the refiner's purpose, the test is reversed. He has his reference fuel made up and wants to know how much lead per gallon he must add to his product to bring it up to standard. Therefore by trial and error, he finds this out by working on the point of maximum knock.

Lead Analyses

It is sometimes stated that only a certain amount of lead is to be added to a fuel. To ensure that this amount has not been exceeded, a lead analysis is made.

The fuel is placed in a separatory funnel and shaken with nitric acid. The acid layer is drawn off and partly evaporated. Sulphuric acid is then poured into the beaker and the rest of the nitric acid evaporated. Water is then added to the sulphuric acid and the lead precipitated as lead sulphate. This is filtered off in a Gooch crucible and weighed. It is then an easy matter to calculate the amount of lead tetraethyl per gallon that was in the fuel. This method was developed by the Standard Oil Company of New York, and gives very satisfactory results.

From the above it will be evident that there is no single fuel which is best for every type of engine.

As far as octane number is concerned, and that commands the largest interest at present, if a high compression engine is used, a high octane number fuel is essential. If a lower compression engine is used, it may be operated on a fuel of lower octane number. However, a whole series of tests would have to be made with consideration given to the engine conditions under which the fuel would be used before a definite selection can be made. The real solution is to use a fuel which it is found by experience will give most miles per dollar with the least trouble.

Acknowledgment

Figure 4—Courtesy of C. J. Tagliabue Manufacturing. Co.
Figures 7, 8, 9, 10, 11 and 14—Courtesy of Ethyl Gasolene Corp.
Figure 12—Courtesy of (U.S.) National Advisory Committee for Aeronautics.
Figure 15—Courtesy of Standard Oil Development Co.

The Forty-Ninth Annual General and General Professional Meeting

The Annual General Meeting for 1935 will be convened at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 24th, 1935, at eight o'clock p.m.

After the transaction of formal business, the meeting will be adjourned to reconvene at the Royal York Hotel, Toronto, at ten o'clock a.m. on Thursday, February 7th, 1935, continuing with the professional sessions on the following day.

Programme of Meeting at Toronto

(Subject to Minor Changes)

THURSDAY, FEBRUARY 7th

9.00 a.m. REGISTRATION (Main Mezzanine Floor).

10.00 a.m. ANNUAL GENERAL MEETING (Tudor Room).
Reception and discussion of reports from Council, Committees and Branches.
Scrutineers' report and election of Officers.
Retiring President's address.
Induction of New President.

12.45 p.m. FORMAL LUNCHEON (Roof Garden).
Members $1.00. (Complimentary to visiting Ladies.)
Welcome by the Chairman of the Toronto Branch, R. E. Smythe, A.M.E.I.C., and by His Worship the Mayor of Toronto.
Address by J. B. Carswell, M.E.I.C., of Hamilton, introducing the subject of the afternoon's discussion.

2.15 p.m. PROFESSIONAL SESSION (Tudor Room).
The afternoon will be devoted to a discussion on the **Status of the Engineer.**
C. S. L. Hertzberg, M.E.I.C., will be in the chair.
The discussion will be based on three papers:—
The Engineer in Industry, by R. E. Smythe, A.M.E.I.C.
The Engineer in Private Practice, by J. M. Oxley, M.E.I.C.
The Engineer in The Public Service, by G. J. Desbarats, M.E.I.C.

4.30 p.m. RECEPTION AND TEA for Ladies (Roof Garden).

7.30 p.m. ANNUAL DINNER of The Institute (Ball Room).
The President in the chair.
Dr. A. S. Eve, C.B.E., F.R.S., Dean of the Faculty of Graduate Studies, McGill University, Montreal, will address the members and ladies present.
The Prizes and Medals of The Institute will be presented.

9.30 p.m. RECEPTION AND DANCE (Banquet Hall).
Tickets for Dinner, $2.00 per person.
Tickets for Dance, $2.00 per person.
Tickets for Dinner and Dance, $7.00 per Couple.

FRIDAY, FEBRUARY 8th

9.30 a.m. PROFESSIONAL SESSIONS for the Presentation and Discussion of Papers will be held in three rooms concurrently.

(Hall C)

(*a*) **Research and Testing work for the Hydro-Electric Power Commission of Ontario**, by W. P. Dobson, M.E.I.C., Chief Testing Engineer, H.E.P.C. of Ontario, Toronto.

(*b*) **Gaseous Conductor Lamps and their Applications**, by J. W. Bateman, Manager of Lighting Service, Canadian General Electric Co., Toronto.

(Library)

(*a*) **Simple Graphical Solution for Pressure Rise in Pipes and Pump Discharge Lines**, by R. W. Angus, M.E.I.C., Professor and Head of Mechanical Engineering, University of Toronto, Toronto.

(*b*) **The Montreal Neurological Institute and its Service Equipment**, by F. J. Friedman, M.E.I.C., and C. P. Creighton, A.M.E.I.C., of McDougall and Friedman, Consulting Engineers, Montreal.

(Tudor Room)

(*a*) **The Toronto Waterworks Extensions, a General Description of the Scheme with Details of some outstanding Features**, by William Storrie, M.E.I.C., of Gore Nasmith and Storrie, Consulting Engineers, Toronto.

(*b*) **Three Bascule Bridges of the Simple Trunnion Type**, by H. W. Buzzell, A.M.E.I.C., and R. S. Eadie, A.M.E.I.C., Designing Engineers, Dominion Bridge Co., Montreal.

FRIDAY, FEBRUARY 8th (Continued)

12.45 to 1.45 p.m. BUFFET LUNCHEON (Ball Room). Tickets $1.00.

2.15 p.m. PROFESSIONAL SESSION (Tudor Room).
The afternoon will be devoted to a discussion of **The Water Supply of the Prairie Provinces and its Bearing on their Economic Development.**
Chairman—S. G. Porter, M.E.I.C.
The following communications will be considered:—

(*a*) **Precipitation in the Prairie Provinces**, by John Patterson, Director, Meteorological Service of Canada, Toronto.

(*b*) **Run-off and Stream Discharge in the Prairie Provinces**, by J. T. Johnston, M.E.I.C., Director, Dominion Water Power and Hydrometric Bureau, Ottawa.

(*c*) **Water Conservation in the Prairie Provinces**, by T. C. Main, M.E.I.C., Assistant Engineer—Water Supply, Canadian National Railways, Winnipeg.

(*d*) **The Surface Waters of the Canadian Prairies**, by P. C. Perry, A.M.E.I.C., Division Engineer, Canadian National Railways, Regina.

(*e*) **Domestic Waters in the West**, by W. Calder, Director, Petroleum and Natural Gas Division, Department of Lands, Edmonton.

(*f*) **Relationship of Geology to Soil Drifting in Southern Manitoba and Southern Saskatchewan**, by W. A. Johnston, Chief, Division of Water Supply, and R. T. D. Wickenden, Assistant Geologist, Geological Survey, Ottawa.

(*g*) **Some Possible Sources of Ground Water in Southern Saskatchewan**, by R. T. D. Wickenden, Assistant Geologist, Geological Survey, Ottawa.

(*h*) **Mineral Character of the Underground Waters in Southern Saskatchewan**, by D. C. Maddox, Associate Geologist, Division of Water Supply, Geological Survey, Ottawa.

8.00 p.m. SMOKING CONCERT (Concert Hall). Tickets $2.00.
A variety show with refreshments.
Ladies' THEATRE PARTY (complimentary to visiting Ladies).
For details of Ladies' entertainment, see Ladies' Programme.

SATURDAY, FEBRUARY 9th (Morning)

9.30 a.m. Arrangements will be made for visits to engineering works of interest, such as the following:—
Laboratories of the Hydro-Electric Power Commission, Strachan Avenue.
Laboratories of the Ontario Research Foundation.
Bell Telephone Company's Toronto Toll Equipment.
Victoria Park Filtration Plant.
Factory of the Goodyear Tire and Rubber Co. of Canada.
Details will be announced later.

Hotel Arrangements

Members are recommended to make their reservations as early as possible.

The leading Toronto Hotels quote the following rates:—

	Royal York	King Edward
Single room with bath................	$4.00	$3.00
Double room with bath...............	$7.00	$5.00

Railway Rates

Both railways offer special return rates for groups of ten or more as follows:—

(*a*) Organized parties having a minimum of ten up to fourteen persons: single fare and one half. Time limit sixteen days.
(*b*) Organized parties of fifteen or over: single fare and one quarter. Time limit sixteen days.
(*c*) Rate good on coaches only, a minimum of fifteen persons: single fare and one tenth. Time limit seven days.

All these fares require travelling together on the same train and date, with individual return on any train within the time limit.

THE
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The New Year

The President and Council extend to all members of The Institute a cordial greeting for 1935.

The Old Year closes with many definite indications of improved conditions in Canada which will lead to growing activity in engineering work.

Our difficulties are not yet over, but we are encouraged to await with confidence the events of the coming year.

Construction Contracts and Contract Forms

The engineering side of the construction industry has undergone marked changes during the past twenty years, both in its technical and commercial aspects. Much of the work is now on a larger scale and is carried out by the aid of much more elaborate equipment, which, together with new facilities for inspection and testing, and improved accounting methods, makes it possible for the engineer and the contractor to control more closely the quality and cost of the work. The sub-contractors, each undertaking the work of some particular trade, now play a far more important part than in the past. These and other developments increase the responsibilities devolving upon the parties concerned, and make it more than ever necessary to define clearly the duties and mutual relations of the owner, the engineer and the contractor.

The documents defining these relations, and forming the conditions of contract for the execution of engineering work are, however, of importance not only to consulting engineers and contractors, but to everyone interested in the construction of public works or large buildings, the fabrication of structural work, or the supply and erection of heavy mechanical and electrical equipment. This is particularly the case since the engineering staffs of large corporations are now called upon to undertake some of the design and planning work which used to be entrusted to consulting engineers.

Documents governing engineering contracts have, first, to define the legal relations existing between the owner or purchaser of a projected work, the engineer acting on his behalf, and the contractor and the people working for him. It is then necessary to set forth the general conditions under which the work is to be performed, taking account of the various contingencies which may occur. The parties interested should evidently have some knowledge of the law of contracts, the essentials of which were so ably dealt with in an address given by a Toronto barrister before the Toronto Branch of The Institute in December 1933.[1] Their attention should also be called to the Standard Forms of Construction Contract which have been prepared for, and recently issued by, the Canadian Construction Association, and are now available for public use. These forms[2] have been submitted to and approved by the Council of The Institute as applying to contracts for work to be supervised by an engineer, and (with the word "architect" replacing the word "engineer") also have the approval of the Royal Architectural Institute of Canada in the case of construction coming under an architect's direction.

There are two forms, dealing respectively with work to be done for a stipulated sum, and work to be done when the contractor's remuneration is a percentage of cost or a fixed fee. Each form consists of two parts, the Agreement between the Owner and the Contractor, and the General Conditions of the Contract.

The principal clauses of the Agreement relate to the contractor's undertaking for the proper and complete performance of the work by him and his sub-contractors, the owner's undertaking to pay the contractor, and, in the case of a cost-plus contract, the exact way in which the cost shall be computed.

As regards the General Conditions, these first define the contract documents, including the drawings and specifications, and set forth the respective responsibilities of the engineer and the contractor as regards these. The engineer's powers and duties are next stated as to the interpretation of the contract and the supervision and inspection and approval of the work. The clauses which follow deal with the correction of faulty work, the protection of the owner's property and the work while in progress, insurance, and the powers of the engineer to stop the work in an emergency. The difficult subject of changes or additions is next taken up, followed by various provisions regarding the engineer's certificates, payments, liens, and the contractor's responsibilities in connection with permits and patent fees. The circumstances are stated under which the owner can take over the work or terminate the contract, or under which the contractor can cease work in certain eventualities; the conditions applying to sub-contractors in relation to the owner, contractor and engineer are given, and the final clauses deal with the settlement by arbitration of disputes between the owner, or the engineer on his behalf, and the contractor.

The contract form relating to work done on a basis of cost-plus percentage or fixed sum necessarily differs somewhat in detail from the stipulated sum contract, and omits certain clauses which are found in the latter, but which are not applicable on a cost-plus basis. It contains also certain clauses regarding the engineer's powers, the purchase of materials by the contractor, and methods of accounting and

[1] H. D. Anger, The Law of Contracts and Bonds of Particular Application to Engineers and Architects, Engineering Journal, May 1934.

[2] Canadian Standard Forms of Construction Contract.—Copies can be had from The Manager, Canadian Construction Association, 717 Ottawa Electric Building, Ottawa, Ont.

audit which are not required in the other form, since the ways of remunerating the contractor, and therefore his responsibilities, are different in the two cases.

Both these forms of contract embody the results of years of experience in construction under Canadian conditions on the part of representative engineers, architects and contractors. Their provisions have thus been tried and found to work satisfactorily. Some requirements commonly found in documents of this kind have been omitted or modified as being causes of possible difficulty or dispute. For example, in the stipulated sum contract, the time-honoured statement that "in case of dispute the engineer's decision shall be final" does not appear. Instead it is provided that the engineer is to "decide on questions arising under the contract documents" and if the contractor considers that such decision has been given in error, he notifies the engineer before proceeding to carry it out. Should the engineer maintain his decision, the work is to proceed and any question of cost is to be decided by arbitration.

With contract forms available which have been so carefully prepared, and which are based on such wide experience, good reasons would have to be given by an owner or contractor for departing materially from their provisions, at least in any case of work to which either form is really applicable. Those who are opposed to any kind of standardization, and look upon uniformity as a thing to be abhorred, will perhaps object to these forms as an attempt to impose still more hidebound regulations upon a suffering community. This is not the case, for while the standard forms are now available for the convenience and use of the public, there is no legal compulsion to use them. Their employment offers many obvious advantages. For example, when such forms come into general use, an owner contemplating construction, or a contractor proposing to tender for work, will be under no uncertainty as to the effect of the various clauses of a document with which he is already familiar. The disputes which occasionally arise as to the precise meaning of some clause specially written for an individual contract will no longer occur. Contractors will be able to prepare their tenders in the knowledge that the work will be carried out under legal conditions and restrictions to which they are already accustomed. Engineers will be able to advise owners with the assurance that the relations between the owner and the contractor will be clearly defined, so that each party knows beforehand exactly what are his rights and obligations.

There will no doubt be a few cases in which these forms are not applicable as they stand. Such instances, however, will be relatively few, and the Canadian Construction Association and the two organizations which have given approval to the forms in question are to be congratulated on making available to the Canadian public such clear-cut and well tried documents.

Entrance and Transfer Fees

At its meeting on October 6th, 1933, Council thought it desirable to waive the existing provisions of Section 32 of the By-laws, and as a temporary measure reduced the entrance fee for all classes of membership to $5.00. On the recommendation of the Finance Committee, Council has decided to continue this policy for the present. Thus, until further notice, the entrance fee, which should accompany applications for admission as Member, Associate Member, Junior or Affiliate, will be $5.00. There is no entrance fee for admission as Student.

While this reduced entrance fee is in force, there will be no transfer fee, except for transfers from the class of Student, in which case the sum of $5.00 is payable. This follows from the provisions of Section 38 of the By-laws.

The Bank of Canada Directorate

As soon as the method of electing directors for the Bank of Canada was announced, the Council of The Institute, naturally desirous that the engineering profession should have adequate representation on the board, appointed a committee to look into the matter. That committee secured the names of four members of The Institute who were eligible and had been duly nominated, and recommended that their candidature should be endorsed by The Institute.

At its meeting on December 14th the committee report was approved and Council unanimously decided to support the candidature of those members, directing that this should be announced in The Journal with the suggestion that members who are shareholders in the Bank would be well advised to vote for the candidates in question, namely:

W. D. Black, M.E.I.C., Vice-President and General Manager, Otis-Fensom Elevator Company, Hamilton.

J. W. Hughson, A.M.E.I.C., W. C. Hughson and Sons Limited, Ottawa.

W. L. R. Stewart, A.M.E.I.C., Managing Director, The Stewart Construction Company Limited, Sherbrooke, Que.

Arthur Surveyer, M.E.I.C., Consulting Engineer, Montreal.

A brief account of the career of each of these gentlemen follows.

W. D. Black, M.E.I.C., graduated from the University of Toronto with the degree of B.A.Sc. in 1910, and was subsequently resident engineer on the Kentucky River high bridge for Gustav Lindenthal. In 1911 he joined the staff of the Otis-Fensom Elevator Company Limited as manager for Quebec and the Maritime Provinces. In 1918 he was engineer in charge of munitions production for the company, and later, until 1921, he was manager of construction. In 1921-1925 Mr. Black was works manager for the same company, and in 1926 became vice-president and managing director, which office he has held until the present time.

Mr. Black is president of the Industrial Relations Committee of the Canadian Manufacturers' Association, and was this year appointed employers' delegate to the International Labour Conference at Geneva. He has been actively associated with the efforts of the Canadian Construction Association to promote revival in the construction industry.

J. W. Hughson, A.M.E.I.C., graduated from McGill University with the degree of B.Sc. in 1912. From February 1916 until November 1918 he served in the Canadian Expeditionary Force, and in 1917-1918 was with the Canadian Forestry Corps in France, having the rank of Captain. After the war he was for a year in Brooklyn, N.Y., as engineer in charge of Tidewater Paper Mills, and returning to Canada in 1920 he was for some time with the Montreal Engineering Company Limited. In 1923 he became associated with the financial firm of W. C. Hughson and Sons Limited, Ottawa, and has remained with that organization until the present time.

W. L. R. Stewart, A.M.E.I.C., graduated from the Royal Military College, Kingston, Ont., in June 1920. Following graduation he was for a time with Lockwood Greene and Company as assistant on construction work. In 1921-1922 he was with the Abitibi Power and Paper Company and Morrow and Beatty Limited, as assistant resident engineer on the Twin Falls power development, and on townsite development work at Iroquois Falls and Kapuskasing, Ont. He was later engineer on building construction work for the Robert Reford Company, Montreal, and in 1924 was field engineer with the Newton Dakin Construction Company Limited, remaining with that firm until 1927, first as office engineer and estimator at the Montreal office, and then as manager of the Sherbrooke office and district. In March

1927 he founded and became managing director of the Stewart Construction Company Limited, at Sherbrooke, Que. and has held that office up to the present time. He has served as vice-president of the Canadian Construction Association.

Dr. Surveyer graduated from Laval University with the degree of B.A. in 1898, and from the Ecole Polytechnique with the degree of B.A.Sc. and C.E. in 1902. In 1924 the degree of Doctor of Engineering was conferred upon him by the Rensselaer Polytechnic Institute. He commenced his professional career with the Public Works Department of Canada in 1904, and remained with that Department until 1911 when he entered private practice in Montreal. In 1912 he reported to the Federal government on the effect of the Chicago Drainage Canal diversion on the harbours of the St. Lawrence river and the Great Lakes. He was later associated in making a joint report on the advisability of the government guaranteeing the bonds of the Montreal Tunnel Company and the Montreal Central Terminal Company. During his career Dr. Surveyer has been employed in a consulting capacity by many important cities in the province of Quebec as well as the Department of Public Works, Canada, the Department of Lands and Forests, Quebec, and the Quebec Streams Commission.

Dr. Surveyer has rendered voluntary service for a number of years on the Research Council of Canada. He became President of The Institute in 1924 on the death of W. J. Francis, and served until the end of 1925.

A Proposed Structural Welding Bureau for Canada

The structural fabricating firms of Canada, realizing the great progress that has been made during the past few years in the important art of electric welding and that this art is a very useful tool in the processing of structural units when in the hands of competent operators and under the guidance of technically trained supervisors, have foreseen the necessity of some controlling body for the certification of operators, supervisors and shops.

The rapid growth in the application of welding to structural work is the result of a demand by purchasers, architects and engineers throughout the country, also by the general public for quiet erection, particularly in the large cities.

Specifications covering welded structural building frames, together with a code covering the qualification and testing of operators, are at the present time being formulated by the Canadian Engineering Standards Association. For the protection of the public, it is very necessary that there should be some controlling body for the operation of such a code, through which purchasers and engineers can be assured of good workmanship, combined with open competition. Further, there is the necessity of control to safeguard first class fabricating firms against unfair competition and to prevent an undue distrust in welded fabrication. The public, purchaser, engineer and fabricator can only be adequately protected by the operation of some competent controlling body.

At a meeting of fabricators, representatives from the steel mills, and the engineering profession, held in Toronto on December 13th, 1934, it was decided:—

(1) To form a Structural Welding Bureau.
(2) That the Bureau should control the operation of the Code.
(3) That the membership of the Bureau should be open to all first class fabricators and have the active support of public engineering opinion.
(4) That the Bureau should be put into effective operation without undue delay and as soon as the Code is formulated and accepted by the C.E.S.A.

Such a code and governing authority are not new in this country or the United States and have for instance been in operation for some years in Canada in connection with the fabrication of pressure vessels under the control of the Provincial Departments of Labour. This could also be done with regard to structural welding fabrication, but it was felt that a great deal of time would be lost while provincial laws were being enacted, and there would also be the possibility of having to work under a different code for each province; whereas, if the matter were made nationwide by the formation of a Dominion-wide Structural Welding Bureau, the provinces would adopt the code and operate it if at any time they should see fit.

Efforts have also been made in the United States by some members of the American Welding Society to establish a code and governing authority for structural welding. In Australia, where through lack of adequate riveting facilities, the art of welding has been developed intensively, they have a well-drawn specification and rigid requirements for the training and certification of both operators and supervisors.

At the meeting held in Toronto a provisional committee was formed consisting of Mr. R. K. Palmer, M.E.I.C., of the Hamilton Bridge Company; Mr. R. A. Spencer, A.M.E.I.C., of the Canadian Bridge Company; Mr. C. E. Disher of the Disher Construction Company, and Mr. F. Newell, M.E.I.C., of the Dominion Bridge Company Limited, as Chairman and Secretary, for the purpose of organizing the Bureau and placing it in operation as soon as the code has been formulated and passed by the Canadian Engineering Standards Association.

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Friday, December 14th, 1934, at eight o'clock p.m., with President F. P. Shearwood, M.E.I.C., in the chair, and four other members of Council present.

After consideration it was unanimously resolved that The Institute recommend to the Kelvin Medal Award Committee that the 1935 award of the medal be made to Sir James Alfred Ewing.

Council considered and approved the report of The Institute's committee appointed by Council to make recommendations on questions dealing with the letting of contracts for public works, which had been referred to The Institute by the National Committee on Sound Public Finance, a body sponsored by the Canadian Chamber of Commerce, and it was decided to forward it to the Canadian Chamber of Commerce as a report from the Council of The Institute.

A letter from the chairman of the Winnipeg Branch was submitted stating that the proposals for joint executive control of the Winnipeg Branch of The Institute and the Association of Professional Engineers of Manitoba, had not been approved by the Council of that Association. Accordingly it would not be possible to carry out the proposals, and it had been necessary for the executive committee of the branch to drop the amendments to the branch by-laws which had been approved by Council at its meeting on November 16th. This announcement was noted and received by Council with great regret.

Three resignations were accepted, four requests for reinstatement were approved, a number of members were replaced on the active list, three Life Memberships were granted, and a number of special cases were considered.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

Elections		*Transfers*	
Assoc. Members	2	Assoc. Member to Member	3
Affiliate	1	Junior to Assoc. Member	1
Students admitted	5	Student to Junior	1

The Council rose at eleven twenty-five p.m.

OBITUARIES

Edward Arthur Hoare, M.E.I.C.

With the death at Quebec, Que., on November 23rd, 1934, of Edward Arthur Hoare, M.E.I.C., The Institute loses one of its oldest members, who joined the Canadian Society of Civil Engineers at its formation nearly fifty years ago.

Mr. Hoare was born in Hampshire, England, on December 8th, 1846, receiving his education at a preparatory school in London and the King's School in Rochester, and his engineering training at the Royal Engineers' Depot, Chatham, and in the office of T. W. Wilson, civil and mechanical engineers, in London.

Coming to Canada in 1868, his first appointment was as assistant engineer with the Toronto, Grey and Bruce Railway, which position be held until 1870 when he became resident engineer for the Great Western Railway, the Wellington Grey and Bruce Railway, and assistant engineer for the London, Huron and Bruce Railway. In 1873-1884 Mr. Hoare was resident engineer for the North Shore Railway, and chief assistant to the chief engineer of the same line when it was transferred to the Quebec Government Railways. From 1884 until 1898 he was superintendent engineer for H. J. Beemer, contractor, on railway and waterworks construction, and chief engineer of the Quebec and Lake St. John Railway, and of the Great Northern Railway (from the main line of the Quebec and Lake St. John Railway to Hawkesbury, Ontario). In 1898 Mr. Hoare was appointed chief engineer of the Quebec Bridge and Railway Company, and in 1909 became district engineer of the Quebec Terminals for the National Transcontinental Railway. In 1913 he was appointed superintending engineer for the Federal Department of Public Works, in charge of the St. Charles river harbour improvement works, and held that post until his retirement in 1921.

Mr. Hoare was a Member of the Institution of Civil Engineers (Great Britain). He joined The Institute (then the Canadian Society of Civil Engineers) as a Member on January 20th, 1887, and was made a Life Member on October 17th, 1930.

Lewis Wynne Wynne-Roberts, M.E.I.C.

It is with great regret that we place on record the death at Toronto, Ontario, on December 8th, 1934, of Lewis Wynne Wynne-Roberts, M.E.I.C.

Mr. Wynne-Roberts was born at Caernarvon, North Wales, on November 14th, 1891, and was educated at the South African College School, Capetown, the county school Towyn, Wales, 1907-1909, and the University of London, London, graduating from the latter institution in 1912 with the degree of B.Sc.

Coming to this country in that year, Mr. Wynne-Roberts went to Regina, and until November 1915 was assistant engineer with the Board of Highway Commissioners of the government of Saskatchewan, engaged on bridge construction. At the beginning of 1916 he was with the Ministry of Munitions in England, and from April of that year until November 1919 served with the Royal Engineers as follows: in India as instructor in military engineering; in Mesopotamia with a Sapper Field Company, and in Persia as field engineer on roads and bridges. Returning to Canada, Mr. Wynne-Roberts was engineer in charge of erection of the Barrett plant at Ashbridge's Bay, Toronto, until May 1920, and later, until May 1922, was resident engineer, with the Department of Public Highways, Ontario, on bridge and highway construction. He then became assistant engineer with Frank Barber and Associates, Toronto, and in April 1923 joined the firm of Wynne-Roberts, Son and McLean, consulting engineers, designing and supervising the construction of water supply systems, sewerage systems, sewage disposal plants, pavements, etc., and being engaged on numerous investigations and appraisals of an engineering nature.

Mr. Wynne-Roberts was elected a Junior of The Institute on February 10th, 1914, an Associate Member on July 22nd, 1919, and a Member on April 28th, 1933. He took an active interest in Institute affairs, and in those of the Toronto Branch of which he was chairman in 1928-29. He represented the Toronto Branch on the Council during the years 1930, 1931 and 1932.

L. W. WYNNE-ROBERTS, M.E.I.C.

His untimely death removes one of the most promising of our younger engineers and leaves a gap in their ranks which will be difficult to fill.

Abram Silas Code, A.M.E.I.C.

Regret is expressed in placing on record the death of Abram Silas Code, A.M.E.I.C., at Alvinston, Ontario, on November 23rd, 1934.

Mr. Code was born at Alvinston on September 18th, 1873, and after serving three years with Messrs. Coad and Robertson, Glencoe, Ont., was admitted to the Association of Ontario Land Surveyors in 1896. In the same year he was assistant surveyor for the townships of Archibald and Tupper, and in 1897 he became township engineer for Brooke Township. In 1899 Mr. Code was assistant engineer for the Tilsonburg, Lake Erie and Pacific Railroad, and in 1901 he was engaged on the erection of a steel bridge for Lambton county over the Sydenham river. In 1902 he built two steel bridges for Brooke township, devised a steel bridge for Petrolia, Ont., and made a survey for the Ontario government of Lundy township. He was later town engineer for Watford, Alvinston, Thedford and Oil Springs. Mr. Code was subsequently in private practice in Alvinston, and was a recognized expert in drainage work, having laid out and supervised many drainage projects in south-western and eastern Ontario.

Mr. Code became an Associate Member of The Institute (then the Canadian Society of Civil Engineers) on April 23rd, 1903.

XIVth International Housing and Town Planning Congress

The XIVth International Housing and Town Planning Congress is to be held in London, England, in July 1935. The exact date will be announced shortly, with a preliminary programme. The principal subjects for discussion will be: Rehousing the People; Positive Planning, and Planned Rural Development.

The President of the Congress will be the Right Hon. Sir Edward Hilton Young, M.P., British Minister of Health.

The new developments in housing and town planning in England are of the greatest interest and importance and facilities have been promised that will make the Congress one of the most valuable that the Federation has held.

PERSONALS

A. S. Holder, S.E.I.C., has recently joined the staff of Canadian Industries Limited at Shawinigan Falls, Que. Mr. Holder graduated from the Nova Scotia Technical College this year with the degree of B.Sc.

G. H. Duggan, M.E.I.C., president of the Dominion Bridge Company Limited, and the Dominion Engineering Works, Ltd., has been appointed a vice-president of the Royal Bank of Canada. Mr. Duggan has been a director of that institution since 1916.

Mr. Duggan is a director of the Steel Company of Canada, the Dominion Steel and Coal Corporation, the Montreal Trust Company, the Wayagamack Pulp and Paper Company, and a number of other industrial concerns. He was a director and chief engineer of the St. Lawrence Bridge Company when that company designed and constructed the superstructure of the Quebec bridge.

In 1930 Mr. Duggan was the recipient of the Sir John Kennedy Medal, which is awarded by The Institute not for the presentation of a paper, but as a recognition of outstanding merit in the profession, or of noteworthy contribution to the science of engineering.

James A. Knight, M.E.I.C., has recently been appointed to the staff of Brunner, Mond (Canada) Limited at Toronto, Ont., and will be engaged in research work and the sales development of calcium chloride.

Mr. Knight graduated from the University of Toronto in 1914 with the degree of B.A.Sc., and shortly afterwards went overseas with the Canadian Engineers. Returning to Canada in 1919 he was with the Hydro-Electric Power Commission of Ontario as designing draughtsman until 1926 when he was appointed assistant testing engineer. In 1928 Mr. Knight joined the staff of the Alcoa Power Company as hydraulic engineer on the Chute-a-Caron development, remaining with that company until 1930 when he became designing engineer with the Beauharnois Construction Company at Beauharnois, Que.

Mr. Knight has taken an active interest in the affairs of The Institute, having served on the Executive committee of the Toronto Branch for several years, and as vice-chairman of the Branch in 1928.

M. V. Sauer, M.E.I.C., has been appointed hydraulic engineer and general superintendent of generating stations for the Montreal Light, Heat and Power Consolidated, Montreal.

Mr. Sauer is a graduate of the School of Practical Science, University of Toronto, of the class of 1901, and took a post graduate course in 1902, receiving a fellowship in 1903. Following graduation, Mr. Sauer was with the Ontario Power Company at Niagara Falls, first as draughtsman and later as assistant to the mechanical engineer. He was appointed chief designer of the Niagara Falls Power Company, Niagara Falls, N.Y., in 1905, and the following year was construction engineer for the Iroquois Construction Company, Buffalo, N.Y. In 1907 Mr. Sauer again became associated with the Ontario Power Company, as chief designer, then as mechanical assistant to the engineer-in-charge, and subsequently, in 1912, as mechanical engineer in full charge of design, field and inspection department. He was later connected with the Hydro-Electric Power Commission of Ontario, and occupied a prominent position on the design and construction of the Queenston-Chippawa power development. In 1923 Mr. Sauer became hydraulic engineer for Canadian Vickers Limited, with headquarters at Montreal, and in 1925 he was transferred to Toronto, and was chief engineer of the hydraulic department of the then recently incorporated Vickers and Combustion Engineering Limited. In 1926 he was appointed vice-president of William Hamilton, Limited, at Peterborough, Ont., holding that office until 1928 when he went to Winnipeg, Man., as designing engineer for the Winnipeg Electric Company. In December 1929 Mr. Sauer returned to the east as hydraulic engineer for the Beauharnois Construction Company at Beauharnois, Que., and in March 1934 he was appointed assistant chief engineer for the Beauharnois Light, Heat and Power Company, from which position he has now resigned.

GROTE STIRLING, M.E.I.C.

Grote Stirling, M.E.I.C., Appointed to Cabinet

The Hon. Grote Stirling, M.E.I.C., has been appointed Minister of National Defence and acting Minister of Fisheries in the Bennett Cabinet.

Mr. Stirling was born at Tunbridge Wells, England, on July 31st, 1875, and was educated at University College School, London, and the Crystal Palace School of Engineering, graduating from the latter institution in 1895. Following graduation he was for several years occupied in railway work as assistant resident engineer and resident engineer with the Midland and Great Northern Joint Railways, and in 1907-1911 he was in private practice in Norfolk, England. Coming to this country in 1911, Mr. Stirling was resident engineer during 1912-1913 on the construction of the Black Mountain Water Company's main irrigation system at Kelowna, B.C., and has since been engaged in private practice in that part of the country.

In 1901 Mr. Stirling was elected an Associate Member of the Institution of Civil Engineers, and joined The Institute as a Member in 1927.

He was first elected to Parliament in November 1924, when the seat at Yale, B.C., was vacated by the death of J. A. McKelvie, and he was re-elected in the three succeeding general elections of 1925, 1926 and 1930.

Sir Herbert S. Holt, M.E.I.C., has relinquished the presidency of the Royal Bank of Canada and now becomes chairman of the board and chairman of the executive committee. In assuming the newly created position of chairman of the board, Sir Herbert will continue a connection with the Royal Bank which began nearly thirty years ago with his election as a director in February 1905. He was appointed vice-president of the bank two years later, and became its president on November 16th, 1908.

Born in Ireland in 1855, Sir Herbert Holt was educated in that country, and on coming to Canada in 1873, he became an assistant engineer on the Toronto Water Works. From December of that year until May 1874 he was assistant engineer and transitman on a topographical survey for the Credit Valley Railway, and following this became transitman and assistant engineer on the Victoria Railway. In the next year Sir Herbert was division engineer on the

Lake Simcoe Junction Railway, and he later returned to the Credit Valley Railway as engineer in charge of track, buildings and bridges on 93 miles. From May 1880 to March 1883 he was engineer of the railway, and in addition from February 1882 he was engineer in charge of the draughting office of the Ontario and Quebec Railway. From March 1883 to July 1884 Sir Herbert was assistant superintendent of construction and engineer in charge of construction of track, buildings and bridges on 500 miles of the Canadian Pacific Railway, and in 1885-1886 he was contractor for heavy tunnel and rock work on the Rocky Mountain division of the Canadian Pacific Railway. In 1886 he was contractor on the Ontario and Quebec Railway, and in 1887 contractor and engineer for 40 miles of the Winnipeg and Hudsons Bay Railway. Later Sir Herbert came east, and acquiring control of the Montreal Gas Company and the Royal Electric Company, proceeded to build up around these two companies the organization that is now known as Montreal Light, Heat and Power Consolidated. Sir Herbert Holt's career as a banker dates from 1902 when he became president of the Sovereign Bank, from which he resigned to become a director of the Royal Bank of Canada. He received the honour of knighthood in 1915.

He is one of our senior members, having joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member in 1889, transferring to Member in December of the same year.

ELECTIONS AND TRANSFERS

At the meeting of Council held on December 14th, 1934, the following elections and transfers were effected:

Associate Members

BERRY, Theodore Victor, B.A.Sc., (Univ. of B.C.), Secretary-Treasurer, Vancouver and District Joint Sewerage and Drainage Board, Vancouver, B.C.

TREMBLAY, Solyme Nérée, (Member by exam., Corpn. Prof. Engrs. Que.), engr., Quebec Streams Commission, Montreal, Que.

Affiliate

WINDER, John, chief electrn. and elect'l. engr., Molsons Brewery Limited, Montreal, Que.

Transferred from the class of Associate Member to that of Member

BERRY, Albert Edward, B.A.Sc., M.A.Sc., C.E., Ph.D., (Univ. of Toronto), director, Sanitary Engrg. Divn., Ontario Dept. of Health, Toronto, Ont.

COLHOUN, George A., Grad. S.P.S., (Univ. of Toronto), designing engr., Hamilton Bridge Company, Hamilton, Ont.

MOUNT, Wilfred Rowland, (Camborne Sch. of Metalliferous Mining), res. engr., City of Edmonton, Alta.

Transferred from the class of Junior to that of Associate Member

HALL, Stewart William Sheridan, B.A.Sc., (Univ. of Toronto), plan examiner, City Bldg. Dept., Toronto, Ont.

Transferred from the class of Student to that of Junior

WISHART, William Donald, B.Sc. (E.E.), (Univ. of Man.), Lieut., R.C.C.S., Camp Borden, Ont.

Students Admitted

BURRI, Henry William, (McGill Univ.), 1581 St. Andre St., Montreal, Que.

COUSINEAU, Louis Philippe, (Ecole Polytechnique), 4603 St. Catherine St. East, Montreal, Que.

DEMBITZKY, Thomas, (Univ. of Toronto), 206 Royce Ave., Toronto, Ont.

LONDON, Woodrow Parker, B.Sc. (E.E.), (Univ. of N.B.), 174 Waterloo St., Saint John, N.B.

TRUDEL, Louis, (Ecole Polytechnique), 3450 Berri St., Montreal, Que.

CORRESPONDENCE

The Secretary,
Engineering Institute of Canada,
2050 Mansfield St.,
Montreal, Que.

Vancouver, B.C.
December 20th, 1934

Sir:—

The writer has been much interested in the article by J. B. Macphail, A.M.E.I.C., in the December issue of The Journal, in which he treats of The Hydrostatic Cord.

In the Brooks aqueduct, designed twenty years ago by the writer, the trough is built to this curve-variety as shown in the author's Fig. 2g. In the Brooks aqueduct, the tangents at points of suspension slope at 60 degrees to the horizontal.

Prior to undertaking the design, the writer attempted a mathematical analysis of the curve and arrived at a differential equation similar to that of the author. He realized that integration would involve elliptic functions but his mathematical equipment failed him at that point. However, knowing that the curve was one form of The Elastica, he worked out a method of determining the *X-Y* co-ordinates by a mechanical process. Preliminary work to determine the best form—i.e., the best tangent angle—was done with a piece of clock spring and a planimeter. The final determination of the co-ordinates was made full size with a spline of clear fir ¾ by 3 inches supported on bicycle balls to eliminate friction. After the spline was bent to approximate shape, the platform was jarred until apparent movement ceased. The co-ordinates were then measured and recorded. This was repeated several times with different splines. Each spline was used four times—turned end for end and inside for outside—and, while differences in the co-ordinates were observed, none were of great magnitude. The average of all was finally adopted. Later, the writer worked out an approximate method of calculating the co-ordinates from the property that the radius of curvature varies inversely with the depth of the point below the surface. This calculation checked, but did not alter the values from the splines.

The shell of the aqueduct is concrete with tension reinforcement in two layers. The question of stresses under a partial load—partially filled—came up. These could be calculated approximately and appeared to be moderate but, to make sure, a full-size model was tested. Deflections were found very small, and the apparent stresses much less than were calculated.

H. B. Muckleston, M.E.I.C.

BOOK REVIEWS

Die Castings

By Herbert Chase, John Wiley and Sons, New York, 1934. 6 by 9¼ inches, 264 pages, $3.50. Cloth.

Reviewed by H. P. Ray*

For anyone wishing to keep abreast of the times, as to the progress made of recent years in the art of die casting, a perusal of this book would be well worth while.

To one who had trouble with some of the die castings produced a decade or two ago, it is very interesting to learn that die casters have now discovered the cause of such defects as dimensional instability, and intergranular corrosion, and take such precautions with their alloys that the faults too often prevalent in the early die castings have been practically eliminated.

The first third of the book contains many halftone illustrations of die castings made for various applications: automotive, household, office and store, machine, electrical, instrument, hardware, liquid and gas, toy and sporting and ornamental. The footnotes under the illustrations are very complete in giving information as to the basic alloy used for the part illustrated, and, if relevant, the reason for the choice is also stated.

The next chapter deals with alloys: zinc, aluminum, copper, tin, lead and magnesium. Several tables give both the composition and physical properties of alloys codified by the A.S.T.M. or the S.A.E. and the same information on alloys commonly used but not yet codified by a national society.

A chapter on the design of die castings is well illustrated with line drawings of typical castings. The main dimensions and tolerances on particular dimensions give one a good idea of the size of castings, and the degree of accuracy at present attainable. The author wisely stresses the desirability of complete co-operation between the customer and die caster. Co-operation usually reacts to the benefit of both parties, particularly the customer, for the die caster has many stunts in his bag of tricks.

A chapter on specifications, inspection and tests fully covers these details.

The last chapter gives a comprehensive outline of the various types of finishes available for die castings. It covers the preparation of the surface to receive the subsequent finish; the technique of plating with nickel, chromium, copper, silver and gold; and the application of the organic finishes: paints, varnishes, enamels, lacquers and japans.

*Northern Electric Company, Montreal.

Industrial Standardization

By John Gaillard, the H. W. Wilson Company, New York, 1934. 6¼ by 9 inches. 123 pages. $2.00. Cloth.

Reviewed by B. Stuart McKenzie, m.e.i.c.*

This book is an engineering thesis written by the author in preparation for a higher engineering degree in a European university. He has, for some years, occupied the position of mechanical engineer on the staff of the American Standards Association, and as such has been responsible for the mechanical features of A.S.A. specifications and has been the representative of that organization at conferences of the International Standards Association held at various European centres. He is therefore well equipped to speak with authority on standards from both the American and the European point of view.

Starting with the evolution of types of standards in the early stages, he traces the development through different types of industry, outlining the essential functions of standardization and discussing technical and managerial standards. He discusses also the benefits of standardization in company organization, with special reference to design, manufacture, inspection and testing, giving information on the technique of standardization and simplification. The author deserves special mention for the summary which appears at the conclusion of each chapter.

Chapter I, on the evolution of standardization, notably the discussion of the human factor, can be commended to the thoughtful consideration of those who have an honest desire to inform themselves on the underlying principles of standardization; principles which are all too seldom appreciated by those in whose interests the work is prosecuted.

In Chapter II, the author cites the case of the automobile industry, one of the most outstanding examples of what intelligent standardization can accomplish in the mechanical field, and he makes special reference to the work of the Society of Automotive Engineers.

In Chapter III, the author enunciates a comprehensive definition of a standard and proceeds to discuss it in detail under two main headings, technical and managerial, the first dealing with mechanical or scientific matters and the second with an even more important feature, the human element.

Chapter IV, is somewhat technical, dealing with interchangeability, limits and fits and tolerances, and the standpoint of the mechanical engineer is here somewhat emphasized.

In Chapter V, the author traces the development of standardization mainly in the United States, giving some data on expenditures on this work. Reference is made to the work of Mr. F. W. Taylor, who as far back as 1895 set forth his principles of shop management, which were at that time received with little enthusiasm by engineers and industrialists. Now, however, these principles have proved to be essentially sound as evinced by the increasing interest which trade associations are taking in the work of industrial standardization.

Chapter VI deals with standards in a manufacturing concern, indicating the relation between a standards department and the other departments involved and stressing the benefits accruing to each department. This matter is considered under three main heads, design, manufacturing practice, inspection and testing.

In the concluding chapter the author presents a working plan for a standards department. In elaborating on this plan he deals with company standardization, the position of a standards department, and the technique of standardization work, including redesign and simplification. The summary at the end of this chapter is specially recommended for careful reading.

This book can be heartily recommended to anyone who has a sincere desire for information on an industrial movement which was never more valuable to industry than at the present time.

*Secretary, Canadian Engineering Standards Association, Ottawa, Ont.

Lighting Calculations

By H. H. Higbie, John Wiley and Sons Inc., New York, 1934. 6 by 9¼ inches, 503 pages. Diagrams, tables. $5.00. Cloth.

Reviewed by H. J. MacLeod, m.e.i.c.*

The author of this book is professor of electrical engineering in the University of Michigan and a past-president of the Illuminating Engineering Society. The book has grown from material compiled to supplement text-books in the teaching of this subject over a period of twenty-five years. It is a comprehensive source-book of lighting data which, the author states, is introduced not as an end in itself, but as a basis for questions and problems and as a means to stimulate interest in the subject and to indicate its significance and importance. The author believes in the problem method of teaching and other teachers of illumination will undoubtedly welcome the large number of practical problems which form a considerable portion of the book. Altogether there are about a thousand problems which are designed for the most part so that they cannot be solved by merely imitating an example.

The book is divided into ten chapters with the following titles: Why Bother about Lighting Calculations? Illumination and Light Flux. Candlepower and Point Source of Light. Brightness. Surface Sources of Light. Linear Sources. Multiplying Light by Reflections in an Enclosure. Utilization Coefficient: Efficiency of the Lighting System. Lamps: Light Generators. Visual Effectiveness of Lighting. These titles indicate the general scope of the book which also contains a large number of references for the convenience of readers who may wish to study particular topics in greater detail. While its main purpose is educational, it contains a large amount of information which should be of value to engineers who are interested in the problems of lighting.

The book is stimulating and imparts something of the author's evident enthusiasm for the subject which has not received the general attention that it unquestionably deserves.

*Professor of Electrical Engineering, University of Alberta, Edmonton, Alta.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Naval Architects:
Transactions 1934.

Reports, etc.

American Society of Mechanical Engineers:
Membership list 1934-1935.
Canada, Dept. of Mines, Mines Branch:
Investigations in Ore Dressing and Metallurgy, January to June 1933.
Quebec, Bureau of Mines:
Annual Report 1933. Part A.
Quebec Streams Commission:
22nd Annual Report, 1933.
Canada, Dept. of Mines:
Report for Year ending March 31st, 1934.
Canada, Bureau of Statistics:
Statistics of Steam Railways in Canada, 1933.
The Science Museum, London:
Rubber: its Anti-Oxidants and Preservatives, a bibliography compiled by the Science Library and the Research Association of British Rubber Manufacturers, 1934.
American Society for Testing Materials:
Tentative Standards, 1934.

Technical Books, etc., Received

Mechanics and Applied Heat with Electrotechnics, Moorfield and Winstanley. (*Longmans, Green Company.*)
Profit Engineering, by C. E. Knoeppel. (*McGraw-Hill Book Co.*)
Refrigeration Data Book, 1934-1936. (*American Society of Refrigerating Engineers.*)
Canadian Trade Index 1934. (*Canadian Manufacturers' Association.*)
Mechanical Catalogue, 1934-1935. (*Am. Society of Mechanical Engineers.*)

BULLETINS

Pumps.—A 32-page booklet received from the Decatur Pump Company, Decatur, Ill., gives particulars of the Burks super-turbine pumps. These pumps are manufactured in a number of sizes and can be utilized for various purposes.

Rock Drills.—A 4-page folder issued by the Worthington Pump and Machinery Corporation, Harrison, N.J. gives details regarding the "Rock Master" rock drilling equipment.

Blowers.—The Roots-Connersville Blower Corporation, Connersville, Ind., have issued an 8-page bulletin which gives the characteristics of standard and heavy duty blowers. Examples of the various kinds of installations are given.

Automatic Switches.—A 48-page folder received from S.A. des Interrupteurs Automatiques, Berne, Switzerland, contains information regarding the installation and maintenance of time and cutout switches, group, staircase, temperature, and remote control switches and thermoregulators.

Blowers.—The Autovent Fan and Blower Company, Chicago, Ill., have issued bulletin No. 88, containing 16 pages, which gives particulars of Type D. Uniblade universal discharge blowers together with performance tables of the various sizes.

Unit Heaters.—Catalogue No. 33, issued by the Autovent Fan and Blower Company, Chicago, Ill., gives tables of capacities for various sizes and steam pressures.

Fans.—A 15-page booklet issued by the Autovent Fan and Blower Company, Chicago, Ill., contains particulars of a number of types of fans for various uses with performance tables.

Concrete.—The Portland Cement Association have issued a 32-page booklet entitled "Cement and Concrete Reference Book—1934" which shows the growth of the cement industry in the United States during the past 60 years, together with graphs and tables illustrating the various phases of this growth such as employment provided, roads and streets paved, road, street and airport maintenance costs, etc.

BRANCH NEWS

Calgary Branch

J. Dow, M.E.I.C., Secretary-Treasurer.
H. W. Tooker, A.M.E.I.C., Branch News Editor.

The first of a series of "Thirty-Minute Addresses" to be given by various members with organized discussion constituted the programme for the meeting held on Thursday evening, November 15th, 1934, at which over thirty members of the Calgary Branch and their friends were present. The addresses presented were:

1. "Farming Problems on Irrigation Projects," by R. S. Stockton, M.E.I.C., superintendent of operation and maintenance, Western Section, Department of Natural Resources, Canadian Pacific Railway.
2. "Air Conditioning and Central Heating," by W. B. Trotter, A.M.E.I.C., president and manager of Trotter and Morton Ltd., contractors.

Farming Problems on Irrigation Projects

The use of land in the dry belt of Alberta and Saskatchewan is of outstanding importance and is an engineering as well as a farm problem. In this great area, nearly 400 miles, east and west, and 200 miles wide, there are millions of acres of prairie soil that have been broken by the plough and continuously farmed for grain production. This has resulted in reduced fertility and drifting soil.

Problems of drifting soils extend into the area of greater rainfall and the remedies that have been proposed are as follows:

(*a*) Strip farming for grain, cover crops, and proper cultural practices that will keep the soil furrowed or rough.
(*b*) Building up humus by seeding large areas to native and tame grasses as a permanent method of utilizing the land and also a crop rotation with grains.
(*c*) Carrying a reasonable number of live stock on the farms and using the manure to build up the soil.
(*d*) Conservation of the available run-off water from all streams, rivers and all drainage areas and using it as far as practicable to promote plant growth.
(*e*) The planting of trees and shrubs to break winds.
(*f*) The scientific and careful classification of the land for its best use.
(*g*) The introduction, selection, breeding and propagation of plants most suitable to our climate conditions.
(*h*) Reducing and adjusting land taxes to encourage proper land use and making up any deficiency in necessary tax revenue by increasing the tax on expenditures and dividing the increase as required.

Irrigation and water conservation deserve study and analysis, also the working out of practical reforms should be considered, as well as the further development and safeguarding of our great natural resources. A planned development based on technical surveys and information of the most scientific and complete order would be of the greatest benefit to this vast region.

Those taking part in the discussion were P. J. Jennings, M.E.I.C., O. H. Hoover, A.M.E.I.C., and M. W. Marshall, M.E.I.C.

Air Conditioning and Central Heating

Air conditioning has been defined as the simultaneous control of the temperature, moisture content, cleanliness and motion of the air in an enclosure. It is the interplay of temperature and humidity that complicates the problem of conditioning and both must be considered if comfortable living conditions are to be obtained.

Actually 45 to 50 per cent humidity is considered a reasonable figure, so that for given temperatures and humidity, the amount of water to be evaporated can be calculated for any space. In round numbers the ordinary home will require from 12 to 20 gallons a day in cold weather. In summer the condition is reversed, high temperatures occur with high humidity, and both heat and moisture have to be abstracted. If the temperature only is dropped the relative humidity may be raised and the room is more uncomfortable than before.

Experiments have defined the comfort zone as being the limits of temperature and humidity between which 60 per cent or more of the occupants will feel comfortable.

The problem is further complicated in public buildings by the variable number of occupants; as for instance theatres, necessitating a complicated system of controls and a measure of hand control in addition.

Filters are necessary to clean air, and are usually mechanical. Either dry or viscous ground glass, steel wool, cheese cloth oiled and many other products are used, some require cleaning others are of the throw-away type.

To fully condition the air in any building it will be necessary to have equipment to move heat, cool, filter and moisten the air, and to do all this under strict control which may be done by central installation or by individual units.

Mr. Trotter's lecture was illustrated by a number of interesting slides.

Those taking part in the discussion were Messrs. W. S. J. Miller, A.M.E.I.C., J. Haddin, M.E.I.C., H. J. McEwen, A.M.E.I.C., and W. Adams, following which Mr. J. H. Bird proposed a very hearty vote of thanks to both speakers. The meeting adjourned at 10.15 p.m.

Hamilton Branch

A. Love, A.M.E.I.C., Secretary-Treasurer.
V. S. Thompson, A.M.E.I.C., Branch News Editor.

The Hamilton Branch held a meeting in the Science Hall of McMaster University on November 21st, 1934, when H. B. Stuart, A.M.E.I.C., chairman of the Branch, presided. Owing to several other counter-attractions, the attendance was not up to the usual number, about sixty being present.

W. J. W. Reid, A.M.E.I.C., chairman of the Meetings and Papers Committee, introduced the speaker of the evening, T. Stanley Glover, A.M.E.I.C., a member of the Branch Executive. The Meetings and Papers Committee has presented a variety of subjects at the Branch meetings, and at this meeting the speaker related his experiences in Nigeria, where he served under the British Colonial Office in the Administrative Department and later in the Department of Public Works.

An Engineer in Nigeria

Nigeria was pictured as one unit of a vast Empire, a Crown Colony, of about the same area as Ontario, peopled by twenty million negroes and possibly four thousand transient whites—government officials, missionaries and merchants.

The geography and economics of the Colony were briefly described, also the available transportation facilities. It was interesting to note the expansion of both rail and road communication, also the development of harbours and docks at the various coastal towns.

Mr. Glover explained the duties that devolved upon a political officer, and how he had been trained for such duties in an intensive course in England prior to leaving for Africa. In the case of certain

Forty-Ninth Annual Meeting

Royal York Hotel, Toronto

February 7th, 8th and 9th, 1935

Courtesy of the Toronto Industrial Commission.

Looking North on Lower Bay Street, Toronto

Annual General Meeting.	Annual Dinner.
Reception and Dance.	Smoker.
Technical Sessons.	Plant Visits.

Programme of meeting appears on page 41.

crimes such as murder and slave trading, the British were adamant and demanded the full penalty, but with others justice was freely tempered with mercy, and the Administrator was required to possess and use a large amount of common sense as well as a working knowledge of the law.

Speaking of his work as a Public Works Engineer, Mr. Glover told of the difficulty of obtaining proper material and equipment for certain works and how it was necessary very often to apply what could be obtained locally to complete the work. Even with material and equipment available, there was still the labour problem—not the lack of men but the difficulty of keeping them at work. The payroll was also a source of worry and annoyance; as the native worker is paid in specie the Public Works Engineer has to transport heavy loads of shillings and pennies to pay his large army of workers.

The lecture was fully illustrated by slides, and gave the audience a wonderful picture of the nature of the country, the life of the natives and also the life of the Colonial whites.

After a number of questions had been asked, and answered by the speaker, W. Hollingworth, M.E.I.C., expressed his appreciation of the lecture. He remarked on the wide experience which Mr. Glover had, including military service in France, service with Dr. Grenfell in Labrador, in Tropical Africa, and now in Canada. Adjournment was then made to an adjoining room where coffee and sandwiches were served.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
J. E. Hawkins, S.E.I.C., Branch News Editor.

The regular meeting of the Lethbridge Branch, The Engineering Institute of Canada, was held in the Marquis hotel, Saturday, November 10th, 1934.

The meeting was preceded by a dinner with chairman C. S. Donaldson, A.M.E.I.C., presiding and twenty-nine members and guests present.

During the dinner many delightful selections were played by Mr. and Mrs. Geo. Brown and their orchestra. Interspersed with the community singing ably led by G. S. Brown, A.M.E.I.C., vocal solos by Mr. A. Jarvis and Mr. W. Stott were enjoyed.

After thanking the artists for their enjoyable programme the chairman introduced the speaker of the evening, J. M. Campbell, A.M.E.I.C., divisional engineer, Canadian Pacific Railway, Lethbridge Division.

Economics Old and New

Mr. Campbell, in introducing his subject, said that engineers were continuously dealing with the question of economics in the course of their work and have quite properly graduated from a consideration of economics in their own field to that in a broader field.

Economics may be described as a science, and, while it can be founded on laws that will stand the keenest scientific scrutiny, the present economic system is not so founded.

There are those who say that we have always had booms and depressions and let it go at that, but the more intelligent are applying their skill and thought to the prevention of such recurrences.

The speaker then gave a resume of the changes in economic and social systems that had taken place in recent years. Russia broke away from orthodox capitalism. Italy was under the rule of a powerful dictator and industrial activity had been sorely regimented. In Germany another dictator is doing his utmost to dominate the people of a highly industrialized country smarting under the sense of military disaster with what results we do not yet know. Great Britain, with its vast accumulated wealth and experience, would seem to be endeavouring to stabilize currency as far as may be possible, for the purpose of assisting in export and import trade. In the United States there is the New Deal, a scheme that is being enforced by strong arm methods and which can be blocked by the selfishness or desire for freedom of action of a small minority.

Now, continued Mr. Campbell, consider the economic laws laid down by one of the world's wisest men, Moses, and see if they are applicable to our complicated civilization of to-day.

The first law was that there should be no interest on money, and Mr. Campbell here pointed out the distinction between interest and dividends.

The next law was that of inflation. Here the speaker exhibited charts and graphs illustrating his interpretation of the Mosaic law, the effects of the Sabbatical year, the year of the cancellation of money as well as the Jubilee or fiftieth year, when virtually a new start was again made. The ever-widening gap between the buying and selling or the cost and selling price was shown and in this respect the Mosaic law endorsed the Douglas theory. By inflation and periodical cancellation the circulation of money was insured.

Moncton Branch

V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.

On December 10th, 1934, a supper meeting was held in honour of F. P. Shearwood, M.E.I.C., President of The Engineering Institute of Canada. J. G. Mackinnon, A.M.E.I.C., chairman of the Branch, presided. Mr. Shearwood was introduced to the meeting by C. S. G. Rogers, A.M.E.I.C., who formerly served under him in the Dominion Bridge Company.

In addressing the Branch on Institute affairs, the President stated that he wished to learn the views of members rather than express opinions of his own. Various matters affecting the present and future of The Institute were discussed, including the possibility of amalgamation with the provincial associations. Following the President's remarks, members took part in a discussion. G. C. Torrens, A.M.E.I.C., ex-president of the New Brunswick Association of Provincial Engineers, was of the opinion that the provincial associations would first have to agree among themselves before amalgamation was possible. Such agreement was bound to come although it might take time. When it did come, The Institute could step in and take its place as the national engineering body.

The chairman then called on Mr. J. F. Sexton, who entertained the gathering with "Some Engineering Reminiscences."

The President later addressed the meeting on "Problems of Bridge Erection." With the aid of slides Mr. Shearwood explained the care, ingenuity and skill called for in the erection of structures that mark Canada's development from the Atlantic to the Pacific. Of particular interest, also, were illustrations showing advances being made in the science of welding.

A vote of thanks was tendered the speaker on motion of F. O. Condon, M.E.I.C., seconded by H. J. Crudge, A.M.E.I.C.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Economics Study Group

The first meeting of this group was held on November 21st, 1934, and it is hoped to arrange weekly meetings throughout the winter season.

Some twenty-five members are attending and the lectures will be handled largely by Dr. D. M. Marvin, economist of the Royal Bank of Canada. The course is self supporting and limited to approximately twenty-five. However, all members of the Branch were given an opportunity of enrolling.

The talks are not elementary and are built up around a discussion of current problems including various aspects of "money," the real effect of international credits, etc., with particular reference to the work of those attending.

Application Engineering on Motors and Control

On November 22nd, 1934, Mr. W. C. Raube, industrial engineer with the General Electric Company, Schenectady, N.Y., gave an address on the choice of electric motors and controls to suit different applications. This was accompanied by a series of interesting charts and graphs.

Previous to the meeting a dinner was given for Mr. Raube in the Oak Room of the Windsor hotel.

E. C. Kirkpatrick, M.E.I.C., acted as chairman.

Electrical Section

On the evening of November 23rd, Mr. Raube continued his talk as given on Thursday evening, making his presentation more technical and using the following points as a basis for informal discussion:

The Characteristics I Want — by the industrial user.
The Motor you Should Use — by the manufacturer.
The Motor you Can Use — by the power company.

X-Ray in Medical Science

Dr. W. Lloyd Ritchie, director of the department of radiology at the Montreal General Hospital, delivered a lecture on November 29th, dealing with the X-ray in Medical Science, indicating the value of the penetrative ray in diagnosis, treatment of fracture and disease, and its importance to the doctor, dentist, surgeon and neurologist. A series of slides of X-ray studies illustrated the talk.

B. R. Perry, A.M.E.I.C., presided.

Junior Section Meeting

The manufacture and use of Safety Glass was the subject covered by a talk and sound film given before members of the Junior Section in the Engineering Building at McGill University on December 3rd. This was arranged through the courtesy of Pilkington Brothers (Canada) Limited.

H. W. Lea, Jr.E.I.C., presided.

Design and Application of Gears

On December 6th, Mr. W. P. Muir, chief engineer of the Mining Metals and Plastics Machinery Department of the Dominion Engineering Works Limited, delivered a paper on the design and manufacture of gear applications covering a very wide field. His talk was fully illustrated with slides and proved to be most interesting. Copies of the paper were available to those present.

R. C. Flitton, A.M.E.I.C., acted as chairman.

Mechanical Section

Messrs. M. J. Berlyn, A.M.E.I.C., and C. D. Bailey on December 10th gave short talks further developing Mr. Muir's paper, this with particular reference to certain phases of modern design of gear teeth and manufacturing methods. A movie film illustrated modern methods of gear cutting and was followed by an interesting informal discussion.

The Relationship Between Architecture and Engineering

On December 13th, J. M. Oxley, m.e.i.c., partner of the firm of Chapman and Oxley, architects, Toronto, delivered an address on the above subject treating the similarity, dissimilarity and the points of contact between the two professions.

The architect tends to visulize form and proportion, the engineer tends to think in quantities. The aptitudes of the one perfected by training supplement the other. If the two collaborate from the outset, the advantage is mutual and the client is protected as well by the lowering of cost and superior result. Cases of collaboration, hypothetical and actual were treated and illustrated by slides. Considerable discussion followed.

A. J. C. Paine, a.m.e.i.c., was in the chair.

Previous to the meeting a dinner was held in the Oak Room of the Windsor hotel.

Electrical Section

"Electron Tubes in Industry" was the subject of a paper presented on December 12th by Mr. D. L. West, formerly with the Baird Television Company of London, England, and the Canadian Television Company Limited of Montreal. This covered the application of electron tubes in industrial work, one of the most popular, of course, being the electric eye.

I. S. Paterson presided.

Junior Section

On December 17th two papers were given before this section, "Electrical Control at Rapide Blanc," by Mr. W. Spriggs, and "The Engineer and the Present Economic Conditions," by Mr. Raymond Reed. Both authors are with the Power Engineering Company and though the papers were on widely diversified subjects both proved exceptionally interesting.

W. W. Graham, Jr.e.i.c., acted as chairman.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

Transmission Gearing

An address on the subject of "Transmission Gearing" was given at the noon luncheon of the Ottawa Branch at the Chateau Laurier on November 8th, 1934, by Martin J. Berlyn, m.a., a.m.e.i.c., of Dominion Engineering Works, Montreal. Alan K. Hay, a.m.e.i.c., chairman, presided and in addition head table guests included: Dr. Charles Camsell, m.e.i.c., R. S. Smart, m.e.i.c., Group Captain E. W. Stedman, m.e.i.c., Captain M. Windsor, Dr. R. W. Boyle, m.e.i.c., A. V. Gale, a.m.e.i.c., J. T. Johnston, m.e.i.c., Major W. E. Blue, a.m.e.i.c., Squadron Leader A. Ferrier, a.m.e.i.c., and John Murphy, m.e.i.c.

The address was of a technical nature and was illustrated by lantern slides. Beginning with the premise that the incorrect design of teeth in gearing induces excessively destructive wear upon machinery due to a non-uniform transmission of motion, the speaker traced the successive steps in the generation of tooth profiles with which the transmitted motion would be uniform. These latter were based upon the involute, which is the figure traced by a curve of progressively larger radius.

A large range of tooth forms based upon the involute is possible, all of which will transmit motion uniformly. The shape of the involute is entirely dependent on the diameter of its "base circle" from which the curve is generated. The larger the base circle, the more nearly straight will the sides of the teeth become.

With small pressure angles, the non-effective inner portion of the teeth is undercut to allow a proper meshing. This has a tendency to weaken the strength of the teeth at a point where they should be strongest. The speaker explained how much of this could be obviated by attention to certain features of the design.

The great flexibility of the involute system in permitting the design of gears to fit in existing gear boxes, in varying the ratio slightly for the same centre distance; in varying the length of contact and in securing varying proportions of sliding to rolling contact to suit lubrication conditions.

The address dealt to a considerable extent with commercial considerations influencing the cutting or re-cutting of gearing, and the choice of gearing for various purposes. Thus a type suitable for use while completely immersed in oil might not be quite so effective where the lubrication is by some other method.

Placing Concrete by Pipe Line and Vibration

On Thursday evening, November 22nd, 1934, H. E. McKeen of Montreal, president of H. E. McKeen & Company Limited, and Managing Director of the Electric Tamper and Equipment Company of Canada, Limited, gave an address on the subject "Placing Concrete by Pipe Line and Vibration." The meeting was held in the projection room of the Photographic Section of the R.C.A.F., Jackson Building, and A. K. Hay, a.m.e.i.c., chairman of the Ottawa Branch of The Institute, presided.

Mr. McKeen stated that his interest was first aroused to the possibilities of pumping concrete to place in the fall of 1929. A pump for this purpose had been invented in Germany by a man named Giese, who secured very strong method patents all over the world and licensed individual firms in different countries. Improvements dealing largely with cylinder and valve design were invented by one of the licensees in Holland, named Kooyman, and from a merger of the Giese and Kooyman patents the pump now in use was developed. With this new pump it was quite possible to adopt the standard practice in concreting in this country. Last year, for instance, about one and a half million yards of concrete were so handled, a great deal being on Mississippi lock and dam work where a three-quarter inch slump was used, with aggregate up to two and one-half inches.

The pump is simply a plunger pump with specially designed cylinders, pistons and valves with the concrete entering the pump chamber by gravity instead of by suction. The concrete moves through the pipe line at a comparatively low speed; wear is not excessive, and as the mix has to be lubricated to be pumpable, a badly designed concrete is practically impossible. Although the pump line itself is not very flexible, so far little difficulty has been experienced in devising simple methods of distribution at its outlet.

The pumping of concrete into place may not be possible of universal application but in the speaker's opinion it had very definite advantages in some fields, such as filtration plants, sewage disposal plants or similar jobs where comparatively small quantities of concrete are scattered over large areas. The method, he was inclined to believe, would have a pronounced effect on present day practice in submarine work.

Mr. McKeen devoted the latter portion of his address to methods of concrete placement by vibration. Vibrators—essentially tools devised to increase the workability of the concrete—are of two types: external and internal. The former transmits its vibration through the form, the latter directly within the concrete itself.

The address was followed by several reels of motion pictures illustrating the operation of both single and double action pumps and the use of the vibrators; after which the meeting was given over to discussion.

Peterborough Branch

H. R. Sills, Jr.E.I.C., Secretary.
E. J. Davies, Jr.E.I.C., Branch News Editor.

Annual Dinner

The annual dinner of the Peterborough Branch was held on November 20th, 1934, at the Empress hotel, under the chairmanship of J. W. Pierce, m.e.i.c. President F. P. Shearwood, m.e.i.c., was among the guests and responded to a toast to The Institute proposed by A. L. Killaly, a.m.e.i.c. The president brought messages of felicitation from headquarters and other branches, and spoke of the western convention of The Institute in Vancouver and dealt with a number of other Institute affairs. The guest speaker of the evening was Professor C. W. Woodside of the University of Toronto, who spoke on the subject, "Germany After Two Years of Hitler." Professor Woodside, who spent the recent summer in Germany, withheld the colour of his own opinion and presented in a straightforward manner the evidence observed by himself on this tour. He asserted that he did not wish to be taken as a scaremonger, but declared that the time has come when the world must face the facts about Germany.

Germany After Two Years of Hitler

Devoting first a few words to the good in the Nazi movement, Mr. Woodside said Hitler had brought back to Germans a belief in Germany. The young of the nation have been infused with this belief to a degree of fanaticism. Yet two and three years ago, before Hitler, hardly was there a single German to be found with a trace of faith in the future of the country, he said.

The Nazis have restored order to Germany, he continued. Germany is in an iron hand. Canadians would find it hard to like that type of control, but the Germans are an order-loving people. They find the present ordered regime much more to their liking than the chaos which existed before Hitler.

Between three and four millions of Germans who idled in the streets before the Nazis took control are now occupied, he added. True, three-fourths of them are engaged in war business and many others are in labour camps, yet the situation, from the German viewpoint, has been greatly relieved, he asserted.

Turning to the evil of the Nazi era, he declared that the worst feature is the brutalizing tendency of the movement. Possibly the entire movement is the calculated effort of the leaders to revive the Germany ego, yet it is having a deep and lasting effect on the peoples, he said.

The prejudicing of the entire German future by a campaign of militarism and re-armament is one of the greatest of Nazi evils. From his own observations in Germany he knew the worst rumours of Germany's re-armament to be true.

Mr. Woodside said that the evidence points to no other conclusion than that Hitler is preparing for war. The nation has thrown everything to the winds—economic stability, world respect, treaty agreements and the contentment and prosperity of its people. The manufacturing industries are organized to a degree unsurpassed in wartime itself for war production.

These men who are leading Germany to-day are dangerous, twisted men—the worst product of the Great War. They are not to be trusted.

What can Canadians do about it? Mr. Woodside, asking the question, said it is doubtful if anything can be done. He suggested, however, that the tension could be somewhat eased if the world would tender a friendly hand to Germany, if the world would attempt in some way to show the German people that they are not actually the victims of a world-wide hatred and persecution. Canadians might aid in this by leading the way, he suggested.

Professor Woodside's address was received with great enthusiasm by those present and evoked a lengthy discussion.

R. L. Dobbin, M.E.I.C., drew attention to the absence, due to illness, of two members of the Branch who have long been faithful workers in Branch activities. It was moved and seconded that a message of good cheer and a floral token of appreciation be sent to these members.

Among the guests present were W. E. Bonn, A.M.E.I.C., vice-president of the Toronto Branch; Col. C. S. L. Hertzberg, M.E.I.C., of Toronto, who introduced Professor Woodside; Professor H. E. T. Haultain, M.E.I.C., of Toronto University, and W. E. Ross, A.M.E.I.C., of Toronto, a former chairman of the Peterborough Branch.

Stresses in Wire Rope and Fittings Used With Same

On Thursday, December 13th, 1934, the regular monthly meeting of this Branch was held, at which Mr. C. D. Meals, of the B. Greening Wire Co. Ltd., Hamilton, Ontario, was the speaker and some of the mysteries in the manufacture and multitude uses of wire rope were capably outlined.

Mr. Meals pointed out that wire rope is relatively a modern product, having first been made in Germany in 1834. The first machine-made rope was made in England in 1840. However, the first big stride in wire rope making occurred in 1854 when the first tempered or "patented" steel wire was made in England. This was a revolutionary event and opened up the field of development of the high strength steel wire as it is used to-day. Prior to this, the tensile strength of drawn wire was only 90,000 per square inch.

In the year 1919 one of the largest wire rope makers in the United States started designing their wire ropes in the draughting room, making proper allowance for the angle of lay of the wires in the strand and the strand in the rope. Previously, the making of the rope had been left entirely to the judgment of the rope shop superintendent. Now the practice is to co-ordinate the engineer's field experience with designing and shop practices and, in many cases, the wire rope engineer makes up the complete specifications for a wire for a given service.

Mr. Meals then dealt in a highly technical manner with the complexity of stresses and abuses to which wire ropes are put in their use in the modern mining, contracting, industrial and marine fields.

Wire rope, he pointed out, is sold largely on its tensile strength property, yet it was not until 1918 that a rational formula was developed to determine the breaking strength of a wire. But even after this the formula was overlooked by the engineering world.

The interest evoked by this paper was indicated by the lengthy and animated discussion, and a vote of thanks by A. B. Gates, A.M.E.I.C., and Mr. E. Bruce Fowler, a guest who is also in the wire rope field, was tendered to the speaker through the chairman, V. S. Foster, A.M.E.I.C.

Saint John Branch

F. A. Patriquen, Jr.E.I.C., Secretary-Treasurer.
H. P. Lingley, S.E.I.C., Branch News Editor.

The Automotive Diesel Engine

On September 25th, 1934, a meeting of the Saint John Branch was held in the Admiral Beatty hotel at 8.15 p.m. The chairman, E. J. Owens, A.M.E.I.C., presided, and about thirty members and visitors were present.

The speaker of the evening, J. L. Busfield, M.E.I.C., delivered an address on "The Automotive Diesel Engine." Several slides of graphs, engines and various diesel driven vehicles were shown. The address followed the lines of the article written by Mr. Busfield and published in the July 1934 issue of The Journal. A short discussion followed the address.

Vickers Armstrong Films

On October 18th, 1934, the members of the Branch viewed the Vickers-Armstrongs Ltd. films which dealt with the various branches of industry engaged in by this company, namely steel making, aviation and shipbuilding. About 45 members were present.

Broadcasting Equipment and Methods

On November 20th, 1934, Mr. J. G. Bishop, chief engineer of CHSJ, addressed the Branch on "Broadcasting Equipment and Methods." The speaker spoke of sound and the effect the walls of the studio had on sound waves, and the reason why a studio had to be specially treated for broadcasting purposes. He mentioned the range of frequency that should be transmitted for natural reproduction, the different types of microphones and described the operation of the dynamic type.

He commented on the factors which affect the fidelity or faithfulness of reproduction in its journey through the equipment. The principle of the operation of the radio transmitter was described as well as some of the causes of distortion and the causes and effects of fading.

The speaker explained the synchronization of stations and outlined some of the problems which have to be dealt with in simultaneous operation of two stations on the same frequency and carrying the same programme.

A short discussion followed, and then the meeting adjourned to inspect the broadcasting station CHSJ.

Address by the President

On December 4th, 1934, thirty-six members of the Branch assembled at a dinner meeting at the Admiral Beatty hotel at 6.30 p.m. to meet F. P. Shearwood, M.E.I.C., President of The Engineering Institute of Canada and chief engineer of the Dominion Bridge Co. Ltd., Montreal.

The president spoke of his visits to the Western branches during the past summer and the joint annual meeting of The Institute and the American Society of Civil Engineers at Vancouver recently.

He also spoke on "The Work and Aims of The Institute," and the meeting came to a close after a very interesting illustrated lecture on "Some Problems in Bridge Erection" by Mr. Shearwood.

Saskatchewan Branch

S. Young, A.M.E.I.C., Secretary-Treasurer.

The City Manager Form of Local Government

The regular monthly meeting of the Branch was held in the Dining room, Parliament Buildings, Regina, at 7.45 p.m. Friday, November 16th, 1934, being preceded by a dinner at which twenty-one were in attendance. A. P. Linton, A.M.E.I.C., presided.

After a short business session, the chairman introduced the speaker of the evening, Mr. A. W. Ellson Fawkes, consulting engineer, Moose Jaw, his subject being "The City Manager Form of Local Government."

In introducing his subject, Mr. Fawkes stated that, due to his versatile training, the civil engineer was peculiarly fitted for the job, 75 per cent of city managers in America being engineers.

About four hundred cities on this continent, containing approximately 10,000,000 people, use the city manager form of government; and of these but four have reverted to the former system.

This form of government bases its origin on the introduction of approved business methods into city government. Under this system the council in effect becomes a board of directors. It deals only with questions of policy and in so doing performs two functions, the enacting of required local legislation and the adoption of a budget of expenditures. The manager then makes the departmental allotments thus making an equitable distribution of funds.

The growth of the movement has been retarded by—

(*a*) lack of public interest,
(*b*) local (petty) politics.

The effectives of the system is difficult to estimate but the facts, (1) that it is growing and (2) that but four cities in Canada and the United States have reverted, are significant. Where the plan has broken down, the failure may be attributed very largely to interference by local politicians.

There are three essential requirements to the plan—

(1) Budget,
(2) Budget control,
(3) Centralized purchasing.

The budget should be binding except in cases of genuine emergency. Under our present system of municipal government it is not an uncommon occurrence to have the budget considerably altered at the end of two or three council meetings, the ultimate being a budget completely disorganized.

The value of a budget lies principally in its economy of preventing foolish and unwarranted expenditures. It ties an administration down to a definite policy of expenditure of public funds.

Mr. Fawkes gave as an example of the working of the system the city of Brandon where, through the application of the principles of scientific business methods, over a period of six years as opposed to the previous haphazard methods the cost of administration had been progressively reduced, taxation lowered, and general efficiency increased, the total effect being increased financial credit and a more satisfied electorate. In concluding his address Mr. Fawkes stated that in effect the city manager is the technical head of a municipal corporation acting under a board of directors (the council) but having vested in him powers which ordinarily are exercised by the council.

A hearty vote of thanks was tendered the speaker.

Sault Ste. Marie Branch

H. O. Brown, A.M.E.I.C., Secretary-Treasurer.

The monthly meeting of the Sault Ste. Marie Branch was held in the main dining room of the Windsor hotel on Wednesday, December 5th, 1934, preceded by a dinner with an attendance of about forty-five members and visitors. After the dinner the usual general meeting business was dispensed with and the speaker of the evening, Mr. Jas. S. Dobie, was introduced by the chairman, E. M. MacQuarrie, A.M.E.I.C.

Mr. Dobie's address was on "Reminiscences of Northern Ontario," and was well illustrated with lantern slides. As the speaker has spent a number of years of his professional life on surveys throughout northern Ontario he was able to tell of a great many interesting incidents.

Historical sketches were given of some of the Indian Missions along the Albany river and the work that is being carried on there to-day.

Means of transportation of survey camp equipment and the methods of portaging were illustrated very clearly. Various survey camp sites were shown and the equipment used for office work in the field was described.

The survey problems, of course, were many and varied. Along the low lying lands to the north many flooded areas could only be crossed by wading. Around the rocky shores of the islands and the north shore of Lake Superior suitable station points for the transit were often obtained with great difficulty.

Mr. Dobie's remarks on the country through which the proposed highway along the north shore of Lake Superior would pass was of particular interest at this time. The geological formations and minerals to be found were discussed. The scenery as described and illustrated certainly seemed to be all that could be desired.

At the close of Mr. Dobie's address a very hearty vote of thanks was tendered to the speaker on the motion of Judge F. Stone, seconded by Dr. A. D. Roberts, M.L.A.

Victoria Branch

Kenneth Reid, Jr.E.I.C., Secretary-Treasurer.

The annual meeting of the Victoria Branch of The Institute was held at the Dominion Hotel on December 4th, 1934. The meeting was preceded by a dinner in the hotel at which twenty-seven members and guests of the Branch attended. The specially invited guests included G. M. Irwin, Victoria city engineer, and Arthur Dixon, Deputy Minister of Public Works in the British Columbia provincial government. The most important business of the meeting following the dinner was the election of officers for the ensuing year.

In assuming the chairmanship of the Branch, D. MacBride, A.M.E.I.C., paid glowing tribute to the work of the retiring executive during the past years, particularly to the chairman, H. L. Swan, M.E.I.C., and the Secretary-Treasurer, I. C. Barltrop, A.M.E.I.C., whose untiring efforts resulted in the present good standing of the Branch.

Following the meeting, Norman Yarrow, A.M.E.I.C., manager of the firm of Yarrows Ltd., Esquimalt, B.C., and member of the Branch, gave an illustrated address on the methods and procedure of the launching of large ships with particular references to the launching of the Cunard-White-Star liner *Queen Mary*, and the French liner *Normandie*. Mr. Yarrow dealt with the technical problems and difficulties connected with such engineering feats, and his paper was illustrated with numerous slides.

In collaboration with Mr. Yarrow's paper six reels of motion pictures were shown on three connected subjects, the titles of which are practically self-explanatory, as follows:

> Steel making at the works of the English Steel Corporation, Sheffield,—including operation of Siemens furnaces and heavy forging press.
>
> Aviation—showing the launching and trial flights of the Vickers supermarine *Seagull V*. Trials of the *Scapa* twin engine flying boat, and the erection and tests of the *Vildebeest* aeroplane fitted for carrying torpedoes.
>
> Construction and trials of the P. & O. steamers *Strathaird* and *Strathnavar* at the Naval Construction Works of Vickers-Armstrongs, Limited, at Barrow-in-Furness.

The excellent quality of these films and the universal interest of the subjects made them very favourable indeed, particularly when shown in conjunction with Mr. Yarrow's paper.

The evening concluded by the showing by Mr. Yarrow of a number of excellent slides depicting man's early attempts to soar above the earth in both heavier and lighter-than-air machines.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.
E. V. Caton, M.E.I.C., Branch News Editor.

Geology of the Great Plains

The meeting of October 18th, 1934, with F. V. Seibert, M.E.I.C., in the chair, was addressed by Dr. L. S. Russel, Ph.D., Geological Survey of Canada, who gave a lecture on "Geology of the Great Plains."

Dr. Russel, who has for several years been carrying on investigations of the geology of the Great Plains, gave a most interesting address. He dealt chiefly with the southwestern portion of Alberta and discussed geological history, life in the geological time, and the economic resources of that area.

During the business of the meeting G. E. Cole, A.M.E.I.C., chairman of the Papers committee, addressed the Branch on the programmes for the coming season, mentioning that it was proposed to alternate the meetings between one of general interest and one of technical interest.

The chairman also gave notice of a special meeting to be called on October 25th to consider the question of closer co-operation between the Association of Professional Engineers of Manitoba and the Manitoba Branch of The Engineering Institute of Canada, which members of both associations are invited to attend.

At the meeting of the local Branch of The Engineering Institute on the evening of November 1st, 1934, Professor H. N. Fieldhouse, Professor of History at the University of Manitoba, gave an address on "Germany of Today."

Professor Fieldhouse, who is recognized as an authority on European politics, spent the past summer in a tour of Europe making observations and getting information.

The lecture was extremely interesting and appreciated by all.

A novel feature of the meeting was that an invitation was extended to the ladies to attend.

At the local Branch meeting of The Engineering Institute of Canada, held on Thursday evening, November 15th, 1934, two very interesting papers were presented by Mr. J. L. Greenlaw, B.Sc., and Mr. W. Peterkin, B.Sc., both members of the local branch of the Junior Engineers' Association.

The Science of Lighting

Mr. Greenlaw, who is with the lamp sales division of the Canadian General Electric Company, opened the programme of the evening with a paper on "The Science of Lighting." He first pointed out how the design of proper lighting had evolved from the old trial and error method to the scientific method as used today where design is based on experimentally determined facts. He also touched on the physiological and psychological effects of lighting and brought out some interesting facts, such as—

> In order to effect a general improvement in seeing from a lower intensity of illumination to a higher it is necessary to double the intensity of illumination, and in connection with this he showed that the wattages of present day lamps increased approximately in this geometrical ratio.
>
> Glare, due to high intensity of illumination, produces a nervous muscular tension and is just as fatiguing as a very low level of illumination.
>
> In a test performed on one hundred people with normal vision it was found that the majority of them picked 100 foot candles as the intensity for comfortable seeing.

At the conclusion of Mr. Greenlaw's paper an interesting discussion followed and a vote of thanks was tendered by Dean Fetherstonhaugh, M.E.I.C.

A New Process of Metallization

Mr. Peterkin then commenced his paper, the subject of which was "A New Process of Metallization." He first of all explained this process as consisting of spraying finely divided hot metal on the surface of the material to be metalized. The spray gun used is fitted with air oxygen and acetylene intakes. In the operation of the gun the correct mixtures of oxygen and acetylene are ignited and the material to be atomized is drawn through this flame in the form of a wire and after melting is broken up into fine spray by a stream of compressed air. Part of this air is used to drive a small turbine in the gun which is adjusted to feed the wire into the flame at the correct rate of speed.

This process was investigated back in 1882 but it was not until 1911 that a patent was taken out by Dr. Schoop, a German scientist. It is just recently, however, that the process has been introduced in this country.

Mr. Peterkin pointed out a very large number of applications of this process, such as the building up of worn shafting, the spraying of dairy kettles, the coating of steel parts of seaplanes with cadmium for protection against salt water corrosion, and the spraying of a bridge in Toronto with a coating of zinc.

He also stated that the coating of metal can be built up to any thickness but that one of its properties is that it has no appreciable tensile strength and is very brittle. It has, however, a high compressive strength which of course is an advantage in the case of built up shafting or crank pins.

During Mr. Peterkin's talk a number of questions were asked and at the conclusion a hearty vote of thanks was tendered both these men by T. C. Main, A.M.E.I.C.

The recent consolidation whereby the *Brown Instrument Company* of Philadelphia became a subsidiary of *Minneapolis-Honeywell Regulator Company* of Minneapolis unites two of the largest and oldest firms in the control field. The Minneapolis-Honey well Regulator Company Limited thus rounds out and complements its line of heating, ventilating, cooling, humidifying and air conditioning control equipment for domestic and large building applications as well as its line of automatic process controls.

The Brown Instrument Company's business has been exclusively in the industrial field and consists of a complete line of instruments for indicating, recording and controlling of high temperatures, pressures, flows, liquid levels, CO_2, speeds, etc., serving such varied industries as oil, power, steel, chemical, glass and automotive industries.

Plans are being made for manufacturing and servicing the Brown Instrument line at the Toronto plant of the Minneapolis-Honeywell Regulator Company.

J. T. Donald and Company Limited, Montreal, have been appointed official assayers to the Canadian Commodity Exchange Incorporated, which is the official title of the new silver exchange in Montreal.

Couplings—Parker Appliance Company, Cleveland, Ohio, have issued Bulletin No. 37, containing 64 pages, and giving particulars and price list of the Parker tube couplings and associated equipment.

Leadership, Profits and Recovery

In many countries it is difficult for business to take the lead in efforts to restore prosperity because of public distrust of business leaders. Unusual prosperity seems to break down the homely virtues and in many instances, although by no means generally, to undermine business morality.

While all authorities are in agreement that increased purchasing power is a necessity as a means toward recovery, authorities disagree as to the means by which this end may be best attained. There is a very considerable body of opinion which has advocated an advance in wages as the most direct means of securing increasing national purchasing power. The arguments in favour of this viewpoint have been widely broadcast in recent months and there is no need to do more than mention it in general.

On the other side of this argument is the experience of the individual company executive who is using every means within his power to lower costs and restore his company to a position where it will show profits. Many such executives are in sympathy with the viewpoint previously expressed, but they cannot see how such an argument applies to their own situation, since they have the knowledge that without drastic retrenchment they will be forced to restrict operations or, in extreme cases, to close down and thus accentuate deflation.

During the worst of the depression the maintenance of employment even at low wages may mean less suffering than that which will follow upon a mounting volume of unemployment. The total real income of the country is the total volume of production. As the total volume of production is diminished there must be a corresponding decline in consumption and a proportionate decline in the standard of living. The maintenance of a wage scale which reduces the total volume of production necessarily accentuates depression. If this is a fair statement of the wage policy during depression, let us examine the comparative effects of relatively low wages and of advancing real wages in the early stages of recovery.

The company which has been operating for three or four years without profits is not likely to be willing to pay out in wages the full additional amount which it receives as a result of the first advance in prices which occurs during recovery. Quite aside from the point that the owners have been receiving little or no return on their investments, it is doubtful whether such immediate wage payments constitute the most effective method of cutting down unemployment and increasing the aggregate buying power of the community. In the first place, if wages are increased, the resulting expenditure will add a direct increment to the purchasing power of the community, but it also follows that management will make special efforts to keep down the number of new employees, both by the use of new labour-saving machinery and by other methods of increasing per-man output. If the new increment in revenue goes to capital instead of to wages, the corporation which has been showing no profits for several years, may show reasonable earnings. In terms of values in the security markets the securities of the corporation are likely to advance by at least ten times the increment in earnings. They may advance much more than this, since the psychological situation will have changed from one in which security holders fear the worst to one in which they hope for the best. In the second place, the corporation itself will be in a far better position to undertake and to finance expansion of its own activities, including under this heading, alterations, repairs and improvements as well as direct increases in production. Each of these activities will tend to swell the total volume of wages within the country. In the third place, as the holders of the securities of the corporation begin to see their holdings advance in value, their own reactions to the situation change, and they are willing to realize upon or borrow against the additional values of the securities mentioned to finance expansion of both a corporate and private character. The amazing building programme in Great Britain which has been the feature of their recent recovery, can be clearly identified with the great improvement in values of government and corporation securities beginning with the government's scheme of debt conversion.

Certainly, the question as to whether increased profits should precede or follow upon increase in wages is a subject upon which there has been insufficient research. Which plan will bring about the quickest restoration of employment? Which plan will lead most quickly to an increase in the total volume of wages and a rise in the buying power of the country as a whole?

The government which desires to secure business co-operation in restoring employment must create conditions where profits are possible. Such theories may not sound idealistic, but it is important that in this matter governments should be pragmatic; that they shall do that which brings real recovery by the shortest route. To create that stability which will permit well-managed companies to make profits is an objective well worthy of pursuit. Business is adaptable and can acclimate itself to widely varying conditions, provided those conditions remain stable. Uncertainty as to future legislative action is most disturbing. The business world seeks stability and prosperity can be best attained where basic laws are unchanging and where peace is assured.

—From The Royal Bank of Canada Monthly Letter for November, 1934.

Once Again, Relief or Recovery?

In a recent issue of the *New York Herald Tribune*, Walter Lippman considers a matter that has often been discussed. He tries to reconcile and if possible combine governmental efforts in behalf of relief and recovery.

Much of his analysis is sound, especially when he points out the danger of doling out relief merely to keep body and soul together; he sees that the relief that is cheapest from a pecuniary aspect is also the most demoralizing to its recipient. He sees also the need for administering relief and recovery measures with due regard for their effect upon each other.

* * *

To accomplish Mr. Lippman's original purpose of reconciling relief and recovery there is but one practical course. That is to have a relief programme for relief and a public construction programme for recovery. Experience has taught us that the relief programme must not be permitted to invade and complicate that field of public works construction which now is available to the normal functioning of the construction industry. The purpose of a public works programme is to foster recovery by using the public credit to sustain the process of capital investment until such time as increasing confidence leads private capital into the construction market. This calls for a sound public works programme operated with no taint of relief psychology.

Mr. Lippman's programme would scuttle the recovery of the construction industry in the interest of direct relief, turn back the recovery clock and gamble on the speed with which private enterprise will be ready and able to go in for substantial construction.

—Willard Chevalier in the December 20th, 1934, issue of the Engineering News-Record.

Engineering in Fascist Italy

The engineering operations carried out by the Fascist government during the first ten years of its existence are described in a volume entitled "Opere Pubbliche, 1922-1932" published by the Italian Minister of Public Works.

During that time some 400,000,000 lire have actually been spent, and when the programme has been completed the total outlay will amount to about 1,000,000,000 lire compared with the 347,000 lire during the fifty-two years preceding 1922. This money has, it is claimed, not been expended as a temporary measure to reduce unemployment, but has been directed solely to the development of the trade and industry of the country, the backbone of which is agriculture. Thus hydro-electric plant has been installed to replace foreign coal, watercourses and irrigation works have been constructed, and harbours, railways and roads have been built to assist in the distribution of the produce of the fields. In this way it is hoped that the 300,000 persons, who formerly emigrated each year, will be settled on the large areas of land that have been reclaimed and that the prosperity of the country will be greatly increased.

The network of main highways directly controlled by the state is 12,758 miles long and is administered by a Board. 5,350 miles of these roads have been improved and a further 684 miles are under construction.

In the field of railways, the activities of the state are exerted directly and through the medium of assistance to private enterprise. In all, 1,784 miles of new line have been completed and a further 812 miles are in course of construction.

Under the heading of "Ports and Harbours" it is learned that work has been undertaken at eighty-two places, comprising the construction of basins with an area of 68,000,000 square feet, of 22.4 miles of jetties, and of 29,500,000 square feet of new quayage. These are fully equipped with cargo-handling appliances.

The construction of 4,850 miles of drainage canals and 706 miles of irrigation canals, with their correlated villages and roads, have enabled 1,710,000 acres to be put under cultivation, while when the work is completed the acreage reclaimed will amount to 6,000,000. The most nteresting of these schemes is that on the Pontine Marshes, where 56,000 acres will be reclaimed.

Italy possesses abundant water resources, and in the ten years under review 4,093,518 kw. of plant has been installed in 805 stations, thus nearly trebling the amount available in 1922. Over one hundred reservoirs with a total capacity of 304,090 million gallons have been constructed, and eighteen more with a capacity of 58,750 million gallons are under construction.

—Engineering.

Make your Arrangements NOW to Attend

THE ANNUAL MEETING

The Engineering Institute of Canada

TORONTO, Ont., ***February 7th, 8th and 9th, 1935***

Preliminary Notice

of Applications for Admission and for Transfer

December 27th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in February, 1935.

R. J. Durley, Secretary.

* The professional requirements are as follows:—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

BALDRY—GEORGE EPHRIAM, of 810 Wolseley Ave., Winnipeg, Man., Born at Osgoode, Ottawa Valley, Ont., Oct. 29th, 1883; Educ., Wesley College, Winnipeg, and private tuition; 1901, Carlton Drainage; 1902-03, C.P.R.; 1904-05, general engrg.; 1906, with L. A. Smart organized the Baldry Engineering Company, specializing in concrete foundation work, concrete piles, designing as well as building the Cornwall, Wolseley, Lincoln and Gloucester Apts., and many others, until interrupted by overseas service. On return, resumed old work, and out of such experience has developed a cast-in-place concrete pile. Has put in many hundreds of these piles, possibly 75% of all the foundation work under existing bldgs. that has been done in Winnipeg. At present chief engr., Baldry Engrg. and Construction Co. Ltd., Winnipeg, Man.

References: A. Campbell, E. S. Kent, D. L. McLean, W. Walkden.

CAMPBELL—LORNE ARGYLE, of Rossland, B.C., Born at Perth, Ont., March 5th, 1871; Educ., Perth Collegiate Institute; Member, Executive Council, Assn. of Prof. Engrs. of B.C.; 1889-91, with Edison General Electric Co.; 1891-98, with Can. Gen. Elec. Co. Ltd., from 1896-98 as chief engr.; 1898 to date, with West Kootenay Power and Light Co. Ltd., as Vice-President and General Manager. Since 1906 in charge of all elect'l. and hydraulic engrg. of this company. Responsible for design both electrically and hydraulically of No. 1 Plant, Lower Bonnington, No. 3 Plant, South Slocan, and No. 4 Plant, Corra Linn.

References: G. H. Duggan, H. H. Vaughan, J. M. R. Fairbairn, J. C. Smith, F. Newell, F. P. Shearwood.

DOBELL—CURZON, of Montreal, Que., Born at Sherbrooke, Que., April 21st, 1909; Educ., 1927-29, R.M.C.; 1929-31, sec. treas., Henry Dobell & Co. Ltd., chem. importers and agents, and asst. to govt. inspr. of potash and pearlash; 1931-34, Montreal manager and estimating, Concrete-Masonry Restoration Ltd.; 1934 to date, estimating and sales engr., Gunite & Waterproofing Ltd., Montreal, Que.

References: L. E. Schlemm, L. C. Jacobs, W. McG. Gardner, A. A. Wickenden, G. B. Mitchell, A. R. Chadwick, R. M. Doull, G. M. Wynn.

IRWIN—GIFFORD MELVILLE, of Victoria, B.C., Born at Minnedosa, Man., May 5th, 1885; Educ., B.Sc. (C.E.), McGill Univ., 1919; 1906-09, land surveying in B.C., rld. location and constrn. on G.T.P., topog'r., transitman, inspr.; 1909-10, land surveying and rld. location, revision, prelim. survey, transitman and levelman, G T.P.; 1911-13 (summers), in charge land survey party. Winters at McGill Univ.; 1913-15, employed by chief engr. of Pacific Great Eastern Rly., procuring information from Prov. Govt. offices in Victoria, B.C.; 1919-20, asst. in civil engrg., Univ. of B.C., also timber tester, in Forest Products Labs. of Canada; 1920-23, instructor in Civil Engrg., Univ. of B.C., had charge of lab. course in strength of materials, lectured in materials of engrg., struct'l. engrg., etc., also during vacations was employed as inspr., instr'man., etc., for City of Vancouver; 1923-28, engr., City of Vancouver, chiefly as asst. to roads and sewerage engr ; 1928-32, asst. city engr., Victoria, B.C.; 1932-34, city engr., and water commissioner, City of Victoria, B.C. (17 mos. in acting capacity).

References: C. Brakenridge, R. Rome, H. L. Swan, F. C. Green, J. N. Anderson.

RIMMER—RALPH HORTON, of Arvida, Que., Born at Burlington, N.C., U.S.A., Nov. 22nd, 1896; Educ., B.S. in Chem. Engrg., Univ. of North Carolina, 1918; 1918-19, chemist and inspr., U.S. Navy; 1919, chemist, U.S. Civil Service (Navy Dept.); 1919-22, chemist, E. I. DuPont de Nemours Co., Wilmington, Del.; 1922-28, chem. engr., research bureau, Aluminum Co. of America, Badin, N.C.; 1928-30, chem. engr., ore plant, and 1930 to date, asst. supt., aluminum plant, Aluminum Co. of Canada Ltd., Arvida, Que.

References: F. L. Lawton, M. G. Saunders, J. W. Ward, H. R. Wake, A. W. Whitaker, Jr.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BONN—WILLIAM ERNEST, of 215 Riverview Ave., Toronto, Ont., Born at Barry, Wales, Feb. 28th, 1887; Educ., 1905-11, Glasgow and West of Scotland Technical School, prep. course for M.Inst.C.E.; 1906-09, articled pupil, P. and W. Anderson, engrg. staff; 1909-11, Caledonian Rly., central district engr's staff; 1911-13, res. engr., C.N.R.; 1913-14, with R. B. Herrin, and Co., Toronto Harbour Development; 1914-18, Dept. Public Works, asst. res. engr., Toronto Harbour Development; res. engr., Pier 15, reconstrn. at Saint John, N.B.; office engr., C.N.R. Arbitration; 1918, James Stewart Inc. (Agents) Emergency Corp., stability diagrams; 1918-20, Candn. Stewart Co.; 1920-27, engr. in charge dredging and constrn., Toronto Harbour Commnrs.; 1927-29, chief engr., Roger Miller & Sons; 1929 to date, with Canadian Dredging Co. Ltd., engr. in charge of Toronto district. Estimates, costs, organizing, stability of structures under constrn., design of plant, etc. *(Jr. 1914, A.M. 1918.)*

References: C. S. L. Hertzberg, J. J. Traill, R. E. Smythe, E. L. Cousins, A. B. Crealock.

CREALOCK—ARCHIE BURGESS, of 502 Riverside Drive, Toronto, Ont., Born at Toronto, Jan. 9th, 1893; Educ., B.A.Sc. (Hons.), Univ. of Toronto, 1915; 1912-13 (summers), original surveys of Toronto Harbour Commn.; 1914 (part summer), Toronto and York Roads Commn.; 1915, dfting and estimating on preparation of report of Civic Transportation Committee re transportation facilities in and around Toronto; 1916-17, Canadian Inspecting and Testing Labs. and Imperial Ministry of Munitions. Inspection and physical testing of cartridge case discs, brass rods, etc., Toronto, Detroit, Montreal. 1917, chief examiner, as above; 1918-19, chief examiner, metallurgical work, aeroplane engines, Toronto; 1919-24, bridge dept. of Ontario Dept. of Public Highways, dfting and design; 1924-29, bridge engr. of Provincial Highway System, Prov. of Ontario, in charge of design and constrn. of all bridges on the Provincial System; 1929 to date, consltg. engr. in private practice, Toronto, Ont. *(St. 1914, A.M. 1923.)*

References: P. L. Pratley, J. J. Traill, C. S. L. Hertzberg, J. R. Cockburn, C. R. Young, R. M. Smith, A. A. Smith.

LEGER—OSWALD ERNEST, of Toronto, Ont., Born at Lachine, Que., Dec. 19th, 1889; Educ., McGill Univ., 1911-12; 1907-14, with Dominion Bridge Company; 1914-19, overseas, Can. Engrs., Capt.; 1920-24, asst. chief engr., International Paper Co., New York; 1924-33, vice-president in charge of steel dept., Canadian Vickers Ltd.; at present, asst. to the President, Hamilton Bridge Co. Ltd., Toronto, Ont. *(A M. 1924.)*

References: R. K. Palmer, C. S. L. Hertzberg, P. L. Pratley, A. Love, R. Ramsay.

SMYTHE—RO. ERIC, of 38 Duplex Ave., Toronto, Ont., Born at Merritton, Ont., Feb. 12th, 1895; Educ., B.A.Sc.. Univ. of Toronto, 1926; 1913 and 1914, rodman and instr'man., Welland Ship Canal; 1923-24 (summers), instr'man., City of Toronto; 1915-19, overseas, C.E.F., Col., D.S.O., M.C.; 1919-21, jr.engr., Welland Ship Canal; 1925, designing engr., G.T.R. Western Lines, bridge and grade separation, Detroit; 1926-28, Detroit City Gas Co., design of plant, bldgs. and supervision of constrn.; 1928, Detroit Edison Company; 1928 to date, director, Technical Service Council, Toronto, Ont. *(Jr. 1920, A.M. 1929.)*

References: C. S. L. Hertzberg, J. R. Cockburn, A. B. Crealock, G. L. Wallace, A. M. Reid, C. R. Young.

WILSON—WILLIAM STEWART, of 20 Humewood Drive, Toronto, Ont., Born at Louise, Ont., Jan. 17th, 1894; Educ., B.A.Sc., Univ. of Toronto, 1921; 1920 (summer), dftsman., C.N.R., bridge dept.; 1915-19, overseas, C.E.F., Lieut., Capt.; 1921-22, estimating and supervising constrn. work, Wilson & Falconer; 1922-23, estimator, Dowling-Williams, Ltd.; 1923-26, demonstrator, dept. of engrg. drawing, Fac. of App. Science and Engrg., Univ. of Toronto; 1926-27, estimator, R. W. H. Binnie, gen. contractor; 1927 to date, Secretary, Faculty of Applied Science and Engrg., Univ. of Toronto. During years 1927-34, May to Oct. in each year, estimator for R. W. H. Binnie, making quantity surveys and responsible for preparation of estimates. (*St. 1921, A.M. 1926.*)

References: A. B. Crealock, R. E. Smythe, O. Holden, J. M. Breen, A. U. Sanderson, W. E. Bonn, W. W. Gunn.

WOOD—JAMES ROBERT, of Calgary, Alta., Born at Alexandria, Scotland, April 26th, 1887; Educ., Associate (in Civil Engrg.), Royal Technical College, Glasgow, 1911; 1904-10, ap'ticeship in mech'l. engrg., Crow-Harvey & Company, Glasgow; 1911-12, res. engr. on mill constrn., for T. Pringle & Son, Montreal; 1911-14, dftsman and res. engr. on design and constrn. of several water works and sewage disposal plants, for John Galt Engrg. Co., Winnipeg; 1917-18, water power engr. (hydrometric), Dom. Govt. in B.C.; 1922 (6 mos.), asst. to mech. supt., Imperial Oil Refinery, Regina (temp. position); 1923-27, with Black & Veatch, consltg. engrs., Kansas City, Mo., as res. engr. on various water works, sewage disposal plants, and water filtration plants, in office on design and reports, and in charge of surveys, Blue River intercepting sewer and Goose Creek storm sewer; 1927-28, engr., Pacific Mills, Ltd., Ocean Falls, B.C.; 1928-29, designing engr., City of Vancouver; 1929 to date, asst. city engr., City of Calgary, Alta. (*A.M. 1919.*)

References: A. S. Chapman, P. Turner-Bone, J. Haddin, T. Lees, F. M. Steel, W. Storrie.

FOR TRANSFER FROM THE CLASS OF JUNIOR

COCKBURN—JOHN MACMILLAN, 3617 Decarie Blvd., Montreal, Que., Born at Gravenhurst, Ont., Mar. 8th, 1900; Educ., B.Sc. (Elec.), Queen's Univ., 1924; 1924-27, test and engrg. course at Can. Gen. Elec. Co., Peterborough and Davenport Works, also Head Office; 1928 to date, engrg. on dial telephone central office equipment, Telephone Systems Engrg., Dept., Northern Electric Co. Ltd., Montreal, Que. (*St. 1922, Jr. 1927.*)

References: W. R. Bunting, W. N. McGuinness, L. Lucas, E. S. Kelsey, W. H. Jarand, F. W. Angus, J. F. Plow.

HICKS—BEN CHURCH, of 3455 Prudhomme Ave., Montreal, Que., Born at Bridgetown, N.S., June 20th, 1901; Educ., B.Sc. (E.E.), McGill Univ., 1927; 1923-24, gen. constrn. work on hydro-electric power development for the Nova Scotia Power Commission; 1924-25, hydro-electric power plant operation; 1927-30, relay mtce. engr., and 1930 to date, testing, investigation and research on relays and relay applications, Shawinigan Water and Power Company, Montreal, Que. (*St. 1921, Jr. 1928.*)

References: J. Morse, G. R. Hale, C. V. Christie, S. C. Hill, E. W. Knapp.

JUSTICE—CLAUDE WELLINGTON, of Noranda, Que., Born at Dauphin, Man., Aug. 28th, 1901; Educ., B.Sc. (E.E.), Univ. of Man., 1926; Summer work: 1920 and 1924, C.P.R. rly. constrn.; 1923, instr'man., Pan-American Oil Co., Calif.; 1925, cost clerk, L. E. Meyers Constrn. Co., Chicago; 1926-27, elec. test course, and 1927-1930, jr. asst. engr., Industrial Control Engrg. Dept., Canadian General Electric Co. Ltd., Peterborough; 1930-31, elect'l. demonstrator, elec'l. labs. and assting in work of engrg. dept., University of Manitoba; 1931 to date, asst. to the plant engr., Noranda Mines, Ltd., in constrn. and mtce. dept., on work chiefly elect'l. and mech'l. Supervising design and installn. of electric power circuits and equipment, above and below ground; assting in design and installn. of special elect'l. and mech'l. equipments for the entire plant. (*St. 1925, Jr. 1929.*)

References: E. P. Fetherstonhaugh, J. N. Finlayson, N. M. Hall, W. E. Ross, J. R. Bradfield.

LANGLOIS—WM. LAWRENCE, of Sudbury, Ont., Born at Toronto, Ont., Dec. 14th, 1900; Educ., B.A.Sc., 1923, Univ. of Toronto; R.P.E. Que. and Ont.; 1923, asst. to archt. for Amer. Chinese Mission, Wuchang, China; 1924-25, engrg. dept., Twp. of Etobicoke, Ont.; 1925, jr. designing engr., H. G. Acres Ltd.; 1927, levelman on 6 mile constrn. project, U.S. Bureau of Public Roads, Arizona, U.S.A.; 1929-30, asst. town engr. for Candn. International Paper Co., at Temiskaming, Que.; 1930-32, asst. engr., Dept. of Works, City of Hamilton, Ont., on design of and later in charge of layout in the field on constrn. of filtration plant; at present res. engr. i/c of surveys for and location of, and also constrn. of Sudbury-North Bay Highway, Dept. of Northern Development, Ontario. (*St. 1923, Jr. 1925.*)

References: R. L. Hearn, A. K. Grimmer, J. Stodart, H. S. Phillips, A. M. Mills, H. A. McKay.

MITCHELL, J. MURRAY, of Three Rivers, Que., Born at Westmount, Que., Aug. 27th, 1900; Educ., B.Sc., McGill Univ., 1923; 1923-24, testing materials, Quebec Development Co., Isle Maligne; With the Bell Telephone Company of Canada as follows: 1924-25, student engr. and asst. divn. traffic supervn.; 1925-29, dist. traffic supt., Montreal W. Div.; 1929-31, dist. traffic supt., Montreal C. Divn.; 1931 to date, dist. traffic supt., Three Rivers District. (*St. 1922, Jr. 1930.*)

References: J. C. Antliff, C. L. Brooks, N. H. A. Eager, K. S. LeBaron, J. F. Plow, L. Sterns, A. M. Robertson.

FOR TRANSFER FROM THE CLASS OF STUDENT

DONOHOE—GORDON MILLER, of 102 Guilford St., Saint John, N.B., Born at Saint John, N.B., Aug. 16th, 1907; Educ., B.Sc., Univ. of N.B., 1931; 1931, inspr. of piling at Saint John Harbour reconstrn.; 1932, with Saint John City Engrg. Dept. (*St. 1931.*)

References: J. Stephens, A. F. Baird, D. A. Duffy, E. O. Turner.

DUTTON—WILLIAM LAWRASON, of Chatham, Ont., Born at Ingersoll, Ont., Aug. 5th, 1907; Educ., B.A.Sc., Univ. of Toronto, 1931; O.L.S., 1934; Summers 1928-29-30, Teck-Hughes Mine, Kirkland Lake, Peterborough Utilities, Peterborough, and Union Gas Company, Chatham; 1931 to date, engr. with Union Gas Co. of Canada, Ltd., Chatham, Ont., since April 1934, in charge of survey work, mapping of areas for drilling purposes, gas well locations and elevations, pipe line locations, property surveys, etc. Work includes gas measurement, installn. and mtce. of orifice meters, chart reading, computations and records, preparation of leakage survey reports, also office work—preparation of maps to show gas lines etc. (*St. 1930.*)

References: G. A. McCubbin, R. L. Dobbin, C. H. Mitchell, T. M. S. Kingston, C. R. Young.

FISHER—SIDNEY THOMSON, 410 Victoria Ave., Westmount, Que., Born at Wieseville, Alta., Aug. 8th, 1908; Educ., B.A.Sc., Univ. of Toronto, 1930; 1926 (summer), surveying, Alta. Highway Commn.; 1927 (summer), surveying, City of Edmonton; 1928 to date, design engr., Northern Electric Co. Ltd., Montreal, Que. (*St. 1927.*)

References: W. C. Adams, H. J. Vennes, A. W. Haddow, H. J. MacLeod, R. S. L. Wilson.

HANGO—J. RAYMOND, of Arvida, Que., Born at Brockett, N. Dakota, U.S.A., Nov. 4th, 1904; Educ., B.Sc. (E.E.), Univ. of Alta., 1929; 1923-27 (summers), bridge and bldg. work, Brazeau sub., Alta., C.N.R.; 1928 (5 mos.), elect'l. dept., McGillivray Coal and Coke Co. Ltd., Coleman, Alta.; 1929, 3 mos., grad. course, Canadian Westinghouse Co., Hamilton, Ont.; With Duke-Price Power Co. Ltd., as follows: 1929-30, engrg. asst., 1930-31, asst. to supt. of operation, 1931 to date, asst. elect'l. engr. (*St. 1928.*)

References: F. L. Lawton, M. G. Saunders, A. W. Whitaker, Jr., H. J. MacLeod, R. W. Boyle.

HEDLEY—CUTHBERT EDWARD, of Montreal, Que., Born at Leyton, London, England, Nov. 20th, 1902; Educ., 1926-27, 1928-29, 1931-32, McGill Univ., 1st and 2nd years, engrg., 3rd year, engrg. physics. Cert. of Proficiency, Radio-Telegraphy, East London Wireless College, London, England, Sept. 1931; 1923-26, radio operator, Canadian Marconi Co. Ltd. Operator on ship stations in full charge of station. 1927-28, dftsman., Northern Electric Co. Ltd., telephone circuit dfting dept.; 1929-31, tracer and dftsman., Alcoa Power Co., Arvida, Que.; July to Dec. 1932, and Mar. 1933 to date, inspr., Victor Talking Machine Co. Ltd., inspection and testing of radio components, power transformers, reactors. (*St. 1929.*)

References: C. V. Christie, C. M. McKergow, F. M. Wood, G. O. Vogan, J. H. Wilson.

HURST—WILLIAM DONALD, of 223 James Ave., Winnipeg, Man., Born at Winnipeg, Mar. 15th, 1908; Educ., B.Sc. (C.E.), Univ. of Man., 1930. C.E., Virginia Polytechnic Institute, 1931. R.P.E. Man.; 1926-27, inspr., 1928-29, junior engr., Hurst Engrg. Co., Winnipeg; 1929, lecturer, Survey School, Univ. of Man.; 1930, inspr. in charge, reservoir constrn., City of Winnipeg; 1930-31, teaching Fellow in civil engrg., Virginia Polytechnic Institute; With the city of Winnipeg as follows: 1931, res. engr., reservoir constrn., 1931-32, investigation engr., proposed sewage disposal scheme, 1932 to date, asst. engr. in charge of water works operating branch, and other engrg. matters. (*St. 1927.*)

References: W. P. Brereton, A. J. Taunton, T. C. Main, J. N. Finlayson, E. V. Caton, G. H. Herriot, H. M. White, E. W. M. James.

JUBIEN—ERNEST BURCHELL, of 5549 Queen Mary Road, Montreal, Que., Born at Sydney, N.S., Oct. 30th, 1904; Educ., B.Sc., McGill Univ., 1926; 1925 (summer), elect'l. installn. work, Nfld. Power and Paper Co., Cornerbrook, Nfld.; 1926-27, test course, Gen. Elec. Co., Lynn, Mass.; Nov. 1927 to May 1928, office work, E. A. Ryan, M.E.I.C., consltg. engr., Montreal; 1928 to date, engrg. dept., Canadian Industries Ltd., Montreal, Que. Design and constrn. work on paints and Duco plant, Regina, Sask.; ammonia oxidation plant, Beloeil, Que.; synthetic ammonia plant, Sandwich, Ont.; design work on acid plant, Copper Cliff, Ont., etc. (*St. 1922.*)

References: C. V. Christie, E. A. Ryan, L. DeB. McCrady, I. R. Tait, A. B. McEwen, J. B. D'Aeth.

LALONDE—JEAN PAUL, of 2042 Marlowe Avenue, Montreal, Que., Born at Coteau-du-Lac, Que., July 1st, 1903; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1926; Summers: 1921-22-23, rodman, Quebec Streams Commission. 1924-25, topog'l. survey, plane table; 1926 to date, with J. M. Eugene Guay Inc., Consltg. Engrs., Montreal, at present, chief engr. in charge of office. (*St. 1925.*)

References: S. J. Fortin, A. Frigon, O. O. Lefebvre, A. Mailhiot, B. W. Waugh.

LEWIS—EDMUND KEITH, of 32 Tulip St., Dartmouth, N.S., Born at Belmont, N.S., April 3rd, 1907; Educ., B.Sc., N.S. Tech. Coll., 1930; 1927-28 (4 mos. each), rodman and instr'man., Topog'l. Survey of Canada; 1929 (4 mos.), asst. engr., Nova Scotia Fuel Board, Halifax, N.S.; 1930-32, mech. asst., engr. dept., Aluminum Co. of Canada, Arvida, Que.; 1933-34, meterman, and from June 1934 to date, in charge of meter dept., Imperial Oil Refineries, Ltd., Dartmouth, N.S. (*St. 1929.*)

References: R. L. Dunsmore, C. Scrymgeour, A. W. Whitaker, Jr., M. G. Saunders, F. R. Faulkner, W. P. Copp.

PIDOUX—JOHN LESLIE, of Calgary, Alta., Born at Birmingham, England, June 17th, 1902; Educ., B.Sc. (Civil), Univ. of Alta., 1934; 1928-29 (summers), chainman on power line location, and rodman and dftsman. on hydro-electric development, Calgary Power Co.; 1930 (May-Dec.), rodman on rld. location and constrn., Nor. Alta. Rlys.; With the Main Highways Br., Prov. Dept. of Public Works, Alta., as follows: 1931 (Sept.-Nov.) instr'man., 1932 (summer), supervising gravel surfacing, and June 1934 to date, instr'man. on highway location and constrn. (*St. 1930.*)

References: J. W. S. Chappelle, J. M. Forbes, H. J. McLean, H. R. Webb, R. S. L. Wilson.

SCANLAN—JEREMIAH JOSEPH RENE, of Montreal, Que., Born at Montreal, May 24th, 1905; Educ., B.Sc. (Civil), McGill Univ., 1926; 1920-21 and summer 1922, constrn. clerk, and rodman, Montreal Water Board; 1923-24 (summers), paving inspr., Milton Hersey Co.; 1925 (summer), instr'man., technical service, City of Montreal; 1926-27, stone inspr., Montreal Harbour Bridge, Milton Hersey Co.; 1927 to 1930 with Dominion Bridge Company, struct'l. steel detailing, engr. on erection, and in design dept. 1930-32, engr. with Gem Stone Co., and Crepeau, Gauvin & Scanlan, consltg. engrs. (partnership); 1933, engr. supt., Franki Compressed Pile Co.; 1934 to date, engr., Milton Hersey Company, Montreal. (*St. 1925.*)

References: M. F. Macnaughton, W. Dixon, N. Cageorge, R. W. Mitchell, L. H. Burket, C. G. Porter.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

YOUNG ENGINEER WITH CAPITAL

Contracting engineer will sell part holdings in active company to young engineering graduate desirous of learning contracting business. Salary $65 to $75 per month. Capital needed $7,000 minimum to $10,000 maximum. Location eastern Canada. Apply to Box No. 1090-V.

DRAUGHTSMAN, with pulp or paper mill experience for work in Northern Quebec. Give full information regarding age, education, experience, etc. in first letter to Box No. 1092-V.

AEROPLANE DESIGNER. Candidates must be British or Canadian citizens. Location Canada. Apply giving full details of experience to Box No. 1096-V.

ENGINEER, for aeroplane stress analysis. Man without experience will be considered. Candidates must be British or Canadian citizens. Location Canada. Apply giving full details of experience to Box No. 1097-V.

SALES REPRESENTATIVE FOR WESTERN CANADA

Internationally known firm selling steam heating systems desires one or two sales engineers to represent them in the western provinces. Men already handling other mechanical lines preferred. Apply to Box No. 1098-V.

Situations Wanted

ESTABLISHED SALES ENGINEER. Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., Jun. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

Employment Questionnaire

In December an employment questionnaire was sent to some two hundred members of The Institute registered with the Employment Service Bureau as unemployed and from whom we had not been in communication for some months.

On December 31st replies had been received from just over 50 per cent of those written to with the following result:

40 per cent are still unemployed.

40 per cent are temporarily employed but wish to be retained on our list of those available.

20 per cent advise that they have secured permanent positions.

This is in addition to the number already placed through the Employment Service Bureau and, we believe, makes the outlook for 1935 distinctly encouraging.

It would be appreciated if those who have not yet returned this questionnaire would do so at their earliest convenience in order that complete information may be available for the Annual Meeting of The Institute.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box. No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box. No. 651-W.

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30 Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), O.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting, concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper millwork, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

Situations Wanted

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

Situations Wanted

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

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The Toronto Waterworks Extensions

A General Description of the Scheme with Details of Some Outstanding Features

William Storrie, M.E.I.C.,
Gore, Nasmith and Storrie, Toronto, Ontario.

Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY.—In 1926 the city of Toronto commenced extensions to its water system which were estimated to cost $14,500,000. These are described in the paper and include a new intake in Lake Ontario, 7,500 feet of intake tunnel, a water purification plant to deal with 100,000,000 gallons per day, and capable of extension, one low lift and two high lift pumping stations, 49,000 feet of filtered water tunnel, a 50,000,000-gallon covered reinforced concrete reservoir, together with the necessary additional mains, elevated storage tanks etc., to connect the supply to the five water districts of the city which have an area of about 46 square miles.

The purpose of this paper is to describe in a general way the main features of the extensions to the Toronto waterworks system now under construction and to give a more detailed description of a few of the somewhat unusual features embodied therein. The scope of the work covers too wide a field to attempt to adequately describe in detail all the varied phases of the scheme.

The extensions were decided upon after reports had been submitted by a Board of Engineers in 1912, by Commissioner of Works R. C. Harris in 1913 and by the late William Gore, M.E.I.C., and Mr. H. G. Acres, M.E.I.C., in 1926. This latter report confirmed the recommendation made by Mr. Harris that the site for the main works known as Victoria Park should be adopted. This scheme was ultimately passed by a vote of the ratepayers and the work ordered to be proceeded with at an estimated cost of $14,317,000.

In coming to a decision as to the necessity for increasing the water supply facilities the following conclusions were arrived at as a result of an extensive study of the then existing conditions:—

(1) That the demand rate had reached a point which taxed the capacity of the system beyond the limit of safe operation.

(2) That an extension to the existing system had become absolutely necessary in the public interest.

(3) That Lake Ontario constituted the best available water supply for the extension scheme.

(4) That the intake works for this extension must not be constructed in the neighbourhood of the existing intakes south of Centre Island.

(5) That of all possible intake locations that at Victoria Park was the most suitable under all conditions.

Having fixed on Victoria Park as the proper location for a raw water intake the other main features of the scheme were developed so that the system now under construction consists essentially of the following:—

(*a*) At Victoria Park an intake tunnel ten feet in diameter, constructed in shale, and extending from the shore out underneath the lake bottom a distance of 3,300 feet, into thirty feet depth of water, and terminating in a submerged tunnel shaft. This tunnel has a maximum capacity of 300,000,000 gallons[1] per day.

(*b*) From the end of the tunnel shaft provision has been made for the laying of three concrete lined steel intake pipes, only one of which has been laid, this being eight feet in diameter, 4,172 feet in length, and terminating in fifty feet depth of water. The eight foot pipe installed has a capacity of 125,000,000 gallons per day. The other two pipes will be laid as and when the demand arises.

(*c*) At Victoria Park a low lift pumping station, coagulating basins, filters, reservoir, general offices and laboratory, with provision for treating initially 100,000,000 gallons of water per day, and so laid out as to permit of this capacity being at least doubled in the future.

(*d*) At Victoria Park a high lift pumping station for supplying all that area lying east of the Don river.

(*e*) From Victoria Park the distribution mains for connecting to the existing mains, and also additional feeder mains for supplying the area lying east of the Don river.

(*f*) From Victoria Park a concrete lined filtered water supply tunnel seven feet in diameter, and 31,087

[1] Wherever the word "gallon" is used in this paper the Imperial gallon is referred to.

feet in length, constructed through shale to the existing main pumping station at John street.

(*g*) From John street station a concrete lined filtered water tunnel six feet in diameter, and approximately 18,575 feet in length, constructed through shale to a point on the lake shore road north of the Canadian National Railway tracks, and immediately east of Parkside drive.

Fig. 1—General Layout of System.

(*h*) At the above mentioned point a high lift pumping station for supplying the western and northwestern area of the city, and to further serve as a connecting link to the contiguous northern areas now served or to be served.

(*j*) From the above mentioned Parkdale high lift pumping station a 42-inch diameter distribution main running northwards to connect to the existing system in District No. 2, and a 30-inch diameter distribution main to District No. 1.

(*k*) At the south-east corner of St. Clair avenue west and Spadina road a covered reinforced concrete reservoir with a storage capacity of 50,000,000 gallons for supplying Districts Nos. 2 and 5.

(*l*) At the above site an ornamental elevated storage tank with a capacity of 500,000 gallons for supplying District No. 3.

(*m*) The necessary connecting mains to and from the St. Clair avenue-Spadina road reservoir and elevated tank.

Existing Supply

The existing water supply system of the city of Toronto and district covers an area of about 46 square miles. The area of supply stretches along the northern shore of Lake Ontario, a distance of about 10 miles, and to the north a distance of about 8 miles, measured from the existing water purification plants on Toronto Island. The ground surfaces within the area of supply rise more or less gradually to the north to a height of nearly 400 feet above the lake level. The difficulty of maintaining the proper pressures in the service pipes therefore lies both in the loss of head by friction in the pipes over the long distances traversed by the water and in the rising elevations of the ground surfaces, the more distant areas being at greater elevations. To meet this situation the water supply area hitherto has been divided into seven districts with fairly uniform pressures in each. The new works now under construction are so laid out as to reduce the number of districts to five, one of which is on Toronto Island and supplied directly from the existing water purification plants there. Figure 1 shows a general layout of the completed system.

Districts Nos. 1 and 2 will be supplied from the existing John street pumping station and from the new pumping stations at Victoria Park and Parkdale. Districts Nos. 3 and 4 will be supplied by boosting the pressures from Districts Nos. 1 or 2. The supply in District No. 1 will be balanced as at present by the existing Rosehill service reservoir and similarly the supply in the enlarged District No. 2 will be balanced by the St. Clair service reservoir. A new overhead ornamental tank will balance the supply in District No. 3 and the existing standpipe in District No. 4 has been enlarged to balance the supply within this district. Thus the new works will supply water directly or indirectly at both ends and towards the middle of both Districts Nos. 1 and 2. The balancing reservoirs are situated almost in the centre of the districts to be supplied in an easterly and westerly direction but outside of these districts and to the north in order to secure higher elevations than exist within those districts. A diagrammatic layout of the complete system showing the elevations of the various water districts will be found in Fig. 2.

The present city waterworks system consists essentially of two 6 feet diameter submerged intakes, with the inlets located—one in about 43 feet and the other in about 79 feet depth of water off Centre Island and about 2,190 feet and 2,383 feet respectively from the shore. The water is pumped from the intakes to either the slow sand or drifting sand water purification plants at Centre Island having a total nominal capacity of 100,000,000 gallons per day. A 7,000,000-gallon clear water reservoir adjacent to the filters holds the filter effluent from which the water passes through into two steel pipes, 7 feet and 6 feet in diameter respectively, laid across the island to a tunnel shaft and from thence into a tunnel having a section equivalent to 8 feet 4 inches

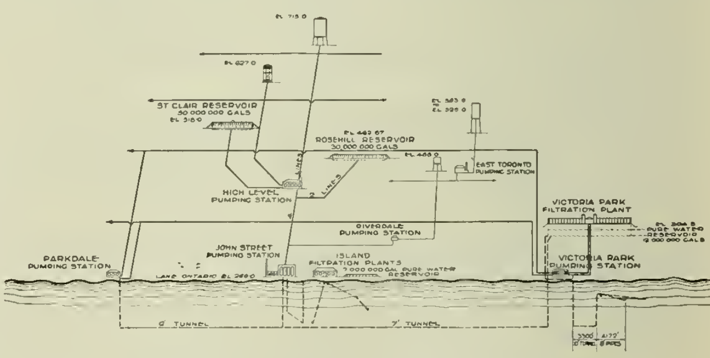

Fig. 2—Elevation of Water Districts

in diameter, which leads underneath Toronto bay to the suction wells at the foot of John street where the main pumping station is located and the water is there pumped into the distribution system throughout the city. The pumping station at John street has a total installed pumping capacity of 212,000,000 gallons per day, of which 102,000,000 gallons capacity is steam driven, and 110,000,000 gallons is electrically operated.

From the John street pumping station the distribution system radiates throughout the city through eight mains, seven of 36 inches diameter and one of 30 inches diameter. The operating pressure on the pumps is 102 pounds per square inch. Filtered water storage reservoirs are provided at Rosehill with a capacity of 38,000,000 gallons and at St. Clair with a capacity of 50,000,000 gallons. The St. Clair reservoir was built as part of the programme of extensions now under way.

The water supply is chlorinated at the island only. Dechlorination with sulphur dioxide for the removal of taste is carried out at the John street pumping station.

Enlargement of Present System

Fortunately the information and records of the conditions existing in Lake Ontario both as to foundation possibilities and the condition of the raw lake water over a long period were available in greater detail than is usually obtainable under similar circumstances. From the standpoint of comparative freedom from physical and bacterial pollution the Victoria Park location was easily the most favourable for a raw water intake. It is the nearest available source of supply of suitable and presumably sustained quality and from a topographical and structural viewpoint equally satisfactory conditions were obtainable. Contour lines of the lake bottom were obtained and a series of borings were made. These borings were taken as far out as 9,600 feet from the shore in 54 feet of water. The borings penetrated the overburden and 25 to 60 feet into the underlying shale formation. A profile of the lake bottom at Victoria Park (Fig. 3) indicates the typical relationship which exists at that point between the surface of the water, the earth overburden and the surface of the rock. This overburden consists for the most part of a 30-foot stratum of stiff clay with a minor admixture of gravel and firm sand, the whole constituting an entirely safe bearing medium for any heavy structure which has its footing depressed sufficiently to prevent any possibility of scour.

Intake

The underlying foundation material in the lake at Victoria Park was such that at any distance up to 6,500 feet from the shore line the construction of an intake tunnel with a reasonable depth of shore shaft offered no unusual working difficulties. The placing of the shore portion of the intake in tunnel avoids the hazards commonly encountered from ice accumulation on the foreshore, where such intakes are laid on or immediately under the lake bottom.

The intake was constructed under two contracts. A shaft was sunk at the shore line to a depth of 110 feet below lake level and 60 feet below the top of the shale. From this shaft a tunnel was excavated through the shale of circular section and 10 feet in diameter of a total length of 3,300 feet. As soon as the shale was excavated the rock surface had a coat of gunite placed thereon thus forming an effective seal which prevented further spalling of the shale and reduced to a minimum the seepage of water through the fissures in the shale. At the outer end of the intake tunnel a junction shaft was constructed forming a connection between the tunnel at elevation 143.27 and a series of three pipes, each 8 feet in diameter, placed at elevation 202.00.

The construction of the junction shaft was carried out by sinking a steel caisson through sand and clay into the rock by means of the pneumatic method. After the caisson had been sealed with concrete at the cutting edge the air pressure was released and the balance of the shaft and the lower elbow were excavated through the rock in the open and the connection driven through into the existing tunnel.

The steel caisson was fabricated and then assembled at a wharf in Toronto bay and when completed was placed in the water, after which the upper section of the caisson was placed on top of the lower part of the caisson. The elbow for the junction shaft was also formed in steel and built into the caisson, the entire structure then being in a floating condition. This steel caisson is 35 feet in diameter and 34 feet high. The working chamber, which was completely encased in steel, had 7 feet 6 inches of head room above the cutting edge. Two access working shafts, each 45 inches in diameter, were constructed from the working chamber roof through the elbow to the top of the caisson. One shaft was used for workmen and the other for handling

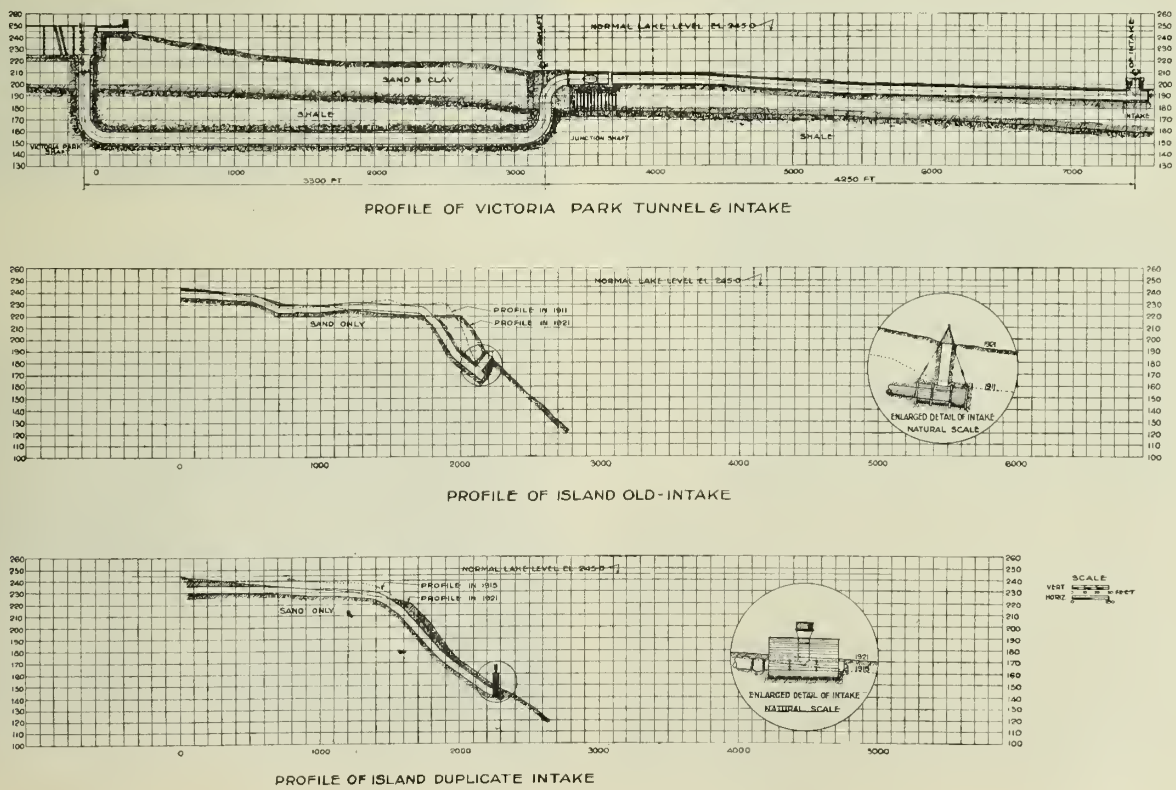

Fig. 3—Profile of Intake Pipes and Tunnel.

the excavated material and concrete. Before the caisson was towed out to its final location in the lake 115 cubic yards of concrete were placed in the caisson, which filled the working chamber walls and about one foot thick over the roof. With this concrete in place the caisson was drawing approximately 17 feet of water which just provided the necessary stability for towing. The caisson was towed out into the lake without any difficulty and placed in position. Some 873 cubic yards of concrete were placed in the caisson in the period of two days after which the two working shafts were extended 40 feet and air locks fitted to the top of each shaft. Under compressed air the excavation was carried on night and day until the cutting edge reached its final elevation of 178.00. Sand, gravel, clay and gravel with some boulders and shale were encountered in the excavation. The air pressure at the start was 15 and at the end 28 pounds per square inch. After the caisson was sealed and the air pressure released the balance of the junction shaft was carried down in the open. All rock was broken up with pneumatic paving breakers, no explosives being used at any time. The steel bulkhead was left in place until the butterfly valve was placed in position and closed, which permitted unwatering of the three-way distributor.

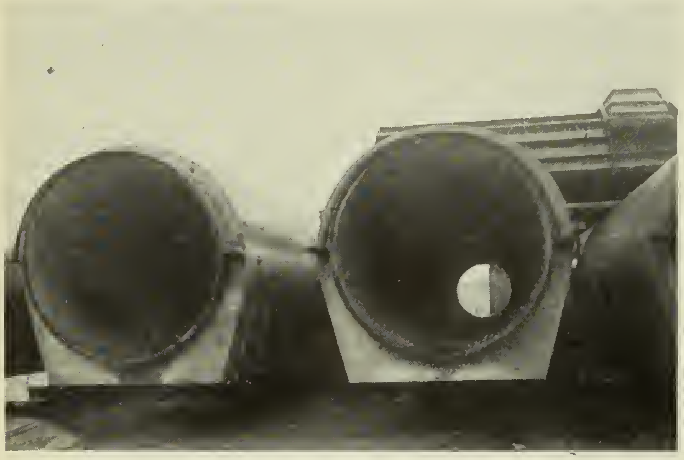

Fig. 4—Intake Pipes 96 inches in diameter ready for Laying.

The three-way distributor connects to the side of the caisson at the upper elbow having a finished inside diameter of 11 feet at this point. The other end of the distributor branches out into three openings, each 8 feet in diameter. Two of these openings have been fitted with watertight bulkheads made of oak timber reinforced with steel. These bulkheads will be removed when additional capacity is required by laying further 8 feet diameter pipes out into the lake.

In the construction of the intake pipe proper the southerly branch of the three-way distributor was used. The distributor weighing 235 tons was constructed on the mainland and placed in position on top of a concrete mat, 3 feet thick, resting on timber piles.

To permit of the tunnel being unwatered at any time an 8-foot diameter butterfly valve is located between the three-way distributor and the first length of intake pipe. The valve is constructed so as to operate by means of a hydraulic cylinder mounted on a cast iron bracket attached to the top of the valve.

From the distributor is laid the intake pipe running in a south-easterly direction, consisting of forty-one sections of pipe, each 100 feet long. These pipes are constructed of steel plate lap welded in courses approximately 7 feet wide. The end courses are ½-inch plate, the middle courses ⅜-inch plate and the balance $\frac{3}{16}$-inch plate. The two ends of each pipe are provided with a half band of 12-inch by ¾-inch plate bent out at right angles at the centre of each side and connected to lug angles. These horizontal extensions have holes 3 inches in diameter. The bands are attached to the upper half on one end and the lower half on the other end of the same pipe thus forming matching connections for succeeding lengths of pipe, held together by 3-inch diameter taper steel pins in the 3-inch holes in the connection lugs. The steel fabricated pipes were conveyed to the contractor's yard in two 50-foot sections and there electrically welded into 100-foot lengths. After being placed on saddles resting on wood bottom forms the outside steel reinforcing was placed. The outside forms were then set and concrete poured forming a horse-shoe shaped outside encasement. Each 100 feet length of pipe required 97 cubic yards of concrete. The inside reinforcing bars were then placed in position and the 2-inch gunite lining completed on the interior. Each section of pipe (Fig. 4) when completed weighed 250 tons. After being thoroughly cured the pipes were placed on a specially constructed derrick boat, taken out into the lake and lowered into position in the trench previously prepared for them.

The pipes had to be transported a distance of almost seven miles and the time of placing these pipes was governed entirely by weather conditions. The derrick boat (see Fig. 5) had to be placed in exact position for lowering the pipe after which divers were stationed at the end of the pipe on the lake bottom and by the use of submarine telephones gave instructions as to shifting of the pipe in

Fig. 5—Placing Intake Pipe, Diameter 96 inches.

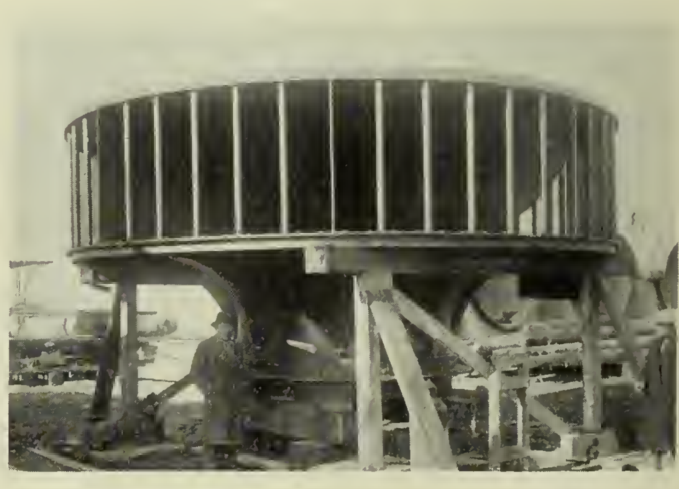

Fig. 6—Inlet to Intake Pipe, Diameter 20 feet.

order to make the connection. Ahead of the laying of the pipe a clamshell dredge carried out the dredging work and after this had been done and before the pipe was laid a gravel bed was prepared on which the pipe was laid.

Precautions were taken to prevent concrete and other material getting into the joints between the pipes and after a sufficient time had expired the concrete joints were poured. The 24-inch length of exposed steel plate was completely encased in concrete, all concrete being placed by the tremie method from a floating concrete plant.

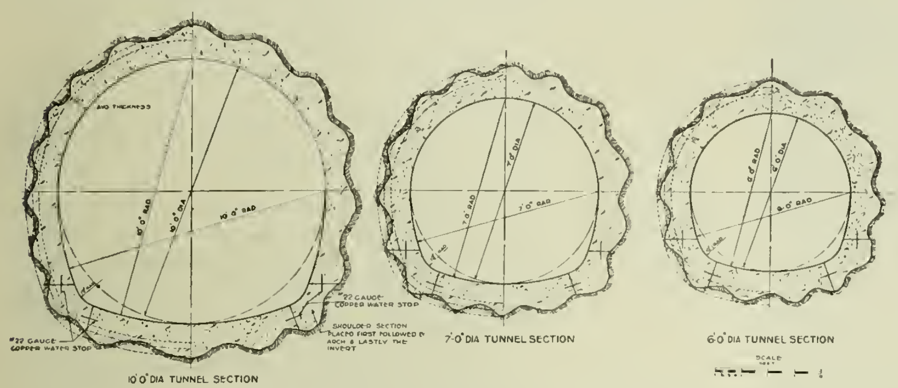

Fig. 7—Sections of Various Sized Tunnels.

At the end of the intake pipe the intake tee is located. This tee is 20 feet long with a 2-inch gunite lining. The outer end of the tee is sealed with a steel plate bulkhead. The 8-foot diameter outlet on top is provided with a flange to which the circular intake is bolted. This intake structure (see Fig. 6) is 20 feet in diameter and divided into eight sections by vertical baffle plates. This furnishes eight rectangular openings arranged in a circle each opening being 7 feet 10 inches wide and 4 feet high. These openings are protected by vertical steel bars 2½ inches in diameter at 15½-inch centres extending from the top to the bottom of the openings. The plates are ⅝ inch in thickness and riveted construction is used throughout.

Tunnels

The raw water intake tunnel under Lake Ontario and the filtered water supply tunnel along the water front were carried out in one contract. From Victoria Park a concrete lined filtered water supply tunnel has been constructed to the existing John street pumping station and continues westward to a pumping station to be erected at Parkdale. The raw water tunnel is 10 feet in diameter, the tunnel from Victoria Park to John street is 7 feet in diameter and from there to Parkdale 6 feet in diameter. At the John street and Parkdale pumping stations surge tanks are provided.

In all, eight shafts were sunk over the entire length of 49,662 feet of filtered water tunnel. A detailed section of each size of tunnel is shown on Fig. 7. After the contract was awarded the section of the tunnel was changed from a true circle to a horse-shoe shape so as to permit of easier transportation facilities. This increased the area of cross section by approximately 5 per cent without any change being made in the contract sum.

The shafts were lined down to the shale level with steel sheet piling and in the shale portion of each shaft the surface was treated with gunite soon after being exposed in order to reduce to a minimum the spalling of the rock. Headings were driven from each shaft and all excavation was taken out in one yard dump cars on a 24-inch gauge track using 25-pound rail, all the hauling being done by ponies. The track was of the one-way type with passing switches. The excavated material was hauled to the surface at each shaft by means of a cage, dumped into a 50-cubic yard hopper and taken away by trucks to a series of disposal areas provided by the city, in most cases in close proximity to the shafts. The line of tunnel being along the waterfront, suitable disposal areas in close proximity to the shafts were secured in connection with the reclaiming of land for harbour development. Generally the shafts were 18 feet in diameter in the overburden where they were lined with steel sheet piling and 13 feet in diameter in the rock. The steel sheet piling was driven by a steam hammer and braced internally with angle rings. The headings were driven 2 feet larger than the finished diameter of the tunnel. The tunnel lining throughout consisted of concrete with a minimum compressive strength of 2,500 pounds per square inch over a twenty-eight-day period. All of the concrete was mixed in transit, then deposited into a 4-cubic-yard hopper at the top of the shaft and placed just below ground level. One-cubic-yard cars were placed on the cage and filled from the hopper, lowered in the cage and hauled along the tunnel to the Ransome pneumatic placing machine which had a capacity of 14 cubic feet for each shot. The concrete was dumped into a box and then placed on the belt conveyor which carried it to the hopper of the pneumatic placer. The concrete was then shot by air into the forms. Steel forms were used throughout and a maximum length of 100 feet was poured at one operation.

The rock shale through which the tunnel was driven disintegrated quickly when exposed to the air. This difficulty was overcome by guniting the walls of the tunnel before the concreting was commenced. The gunite was generally ¾ inch thick and the operation was commenced as soon as possible after the excavated material had been taken out. The gunite successfully prevented further disintegration of the rock and held the surface intact over a period of several months until the final concrete was placed. At each shaft there was erected a pump having a capacity of 130 gallons per minute to take care of the leakage into the tunnel through fissures in the rock and also an electrically driven air compressor for operating

Fig. 8—Steps Forming Ramp in 7-Foot Tunnel.

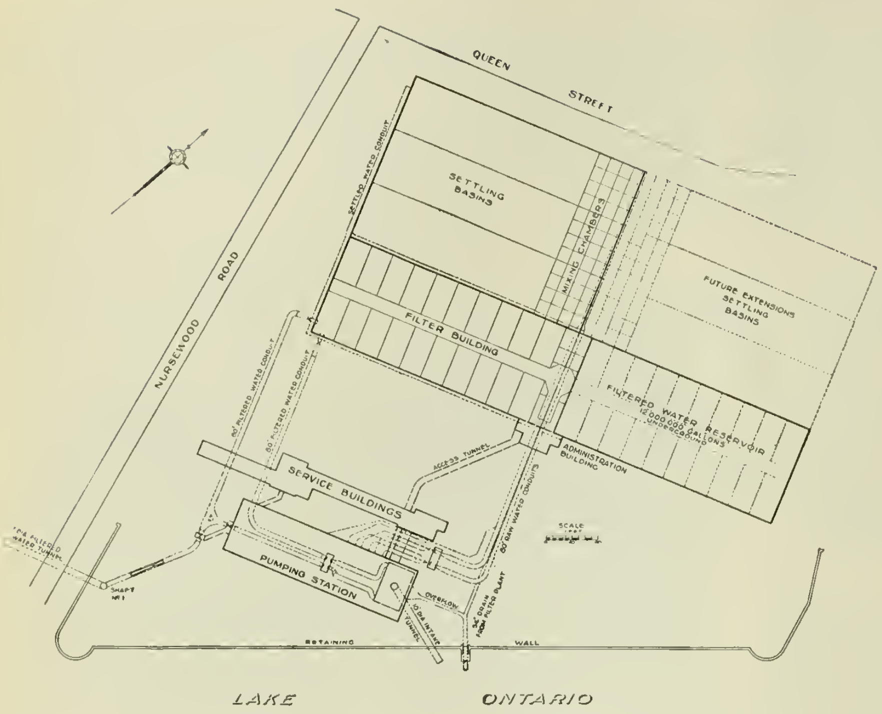

Fig. 9—Layout, Victoria Park Water Purification Plant.

the rock drilling equipment, a double drum mine hoist electrically operated for hoisting the equipment and an electrically driven reversible blower of 2,000 cubic feet capacity for ventilating purposes. These fans developed a maximum pressure of 3½ pounds per square inch. As soon as the blasting had taken place in the heading, the fans, which were supplying fresh air to the heading, were reversed and used to suck the powder smoke from the heading. After running in this way for thirty to sixty minutes the fans were again reversed for pumping fresh air to the underground workings. The air line for the drilling equipment was 4 inches in diameter and for the ventilating air a 10-inch galvanized pipe was used throughout. Figure 8 shows a view of a ramp in the 7-foot diameter tunnel.

Water Purification Plant

The water purification plant and pumping station now in the course of erection at Victoria Park are the major units in the waterworks extension scheme. The general layout of the works at Victoria Park is shown in Fig. 9. The general design of the purification plant was influenced to a large extent by the shape and topography of the site.

The water purification plant consists of a filtered water reservoir, having a capacity of 12,000,000 gallons, over which are constructed the filters, pipe galleries, concourse and chemical room. For the present, twenty filters comprising the western half of the ultimate plant have been completed, together with the administration building, the central concourse and chemical section. Above the concourse and chemical section the wash water tanks are placed.

The portion of the reservoir extending to the east of the main concourse forms the foundation for an additional twenty filters which will give the plant an ultimate capacity of 200,000,000 gallons daily at the standard rate of filtration of 105,000,000 gallons per acre per day. As the roof of the reservoir forms the floor of the filters and pipe gallery all wall and floor castings, filter effluent conduit, concrete Venturi meter, etc., required for the future filters have been constructed where these are located within the reservoir.

The mixing chambers and settling basins are located to the north of the reservoir and filters.

The filters are arranged on either side of a single filter-operating gallery, underneath which is the pipe gallery. The pipe gallery contains only the main wash water and the filter effluent piping, the settled water influent and the wash water waste conduits being at the back of the filters.

Each filter (Fig. 10) is 68 feet long and 35 feet 7 inches wide and has a net filter area of 2,103 square feet which at the standard rating of 105,000,000 gallons per acre per day gives each unit a capacity of 5,000,000 gallons per day.

These filter units are unusually large and particular attention has been given to the design of the wash water system in order to secure an even distribution of wash water and therefore a uniform rate of back wash throughout the whole filter area.

The underdrain system of one filter unit consists of a concrete conduit, 3 feet square in cross section, constructed integral with and underneath the filter floor and along its centre line. The wash water enters this conduit from the 36-inch cast iron pipe in the filter pipe gallery through a 30-inch hydraulically controlled gate valve and then passes upwards through fourteen rectangular ports into a rectangular distribution manifold constructed in concrete. These ports are of sizes and spacing designed to compensate for the varying conditions of flow such as the friction loss, reduction in velocity and increase in pressure along the length of the conduit.

From the manifold the wash water will be distributed through the underdrain lateral pipes which were designed to secure, as far as practical, equal flow through each orifice. The lateral pipes are of cast iron 4 inches in diameter at the inlet end and tapering to 2½ inches and are spaced 12 inches apart. The orifices are on the underside and consist of brass nozzles of ¾-inch bore, also spaced 12 inches apart resulting in one orifice per square foot of filter area. The outer ends of the underdrain laterals are interconnected by a cast iron manifold pipe extending along the side walls of the filter, the purpose of which is to offer a further equalizing effect should the pressure in one area be greater or less than in another.

The filter bed consists of graded gravel to a depth of 18 inches over which is a blinding layer of coarse sand 2 inches thick. Over this, filter sand to a depth of 26 inches will be placed. The filter sand will have an effective size of 0.55 millimeters and a uniformity coefficient of 1.4.

The wash water troughs are of reinforced concrete (Figs. 10 and 11) leading to a central main drain in each filter. The piping in the main gallery is of cast iron throughout and all of the control valves are hydraulically operated. The complete control of the operation of each filter together with the recording apparatus is governed from an operating table situated on the operating floor, one table to each filter. The operating gallery has a terrazzo and marble floor with skylights running throughout the entire length of the building. In order to keep down the cost of heating the building each side of the operating gallery has been enclosed with windows. The outside walls of the building are of gray stock brick with stone trimmings. The flat roof over the filters is of reinforced concrete and covered with cork insulation, felt and gravel roofing.

A feature worth special mention is the provision for chlorinating and dechlorinating the filtered water. The effluent pipes from each filter discharge into a concrete filtered water conduit in the reservoir in which a meter of rectangular section is constructed. After passing through this meter the filtered water is dispersed within a walled area at the centre of the reservoir into which the chlorine solution is diffused. To reach the reservoir outlet the chlorinated water must travel a definite path by reason of the concrete baffle walls, the purpose of which is to ensure a minimum contact period of chlorine and water when superchlorination is practised. Also the path of the water is arranged to permit of dechlorination prior to the water leaving the reservoir.

The purpose of the Venturi meter in the filtered water conduit is to afford a continuous indication of the rate of filtration for the guidance of the chemical operators.

Chlorine and sulphur dioxide will be stored in one-ton cylinders in the chemical storage room. The solution feed machines and evaporators will be located in the chemical machine room directly over the reservoir and within a few feet of the point of application of the chemical. The chemical storage room is equipped with an overhead water fine spray system which can be controlled from outside the room in the event of a major gas leak.

The filter-rate controllers are of the double butterfly valve type and are connected to a central master control which is actuated either by a float on the water level in the reservoir or manually. Under normal working conditions the maximum rate will be set on the manual control but when the water level in the reservoir is within one foot of the overflow the float control will regulate the rate according to the distance the water level is below the overflow.

The whole operation of the filter plant will conform closely to the standard practice used in mechanical filtration. The water will be treated with filter alum or other coagulants which will be supplied from dry feed machines placed in a separate building. Provision has also been made for treating the water with activated carbon should this be found necessary.

One of the main features connected with the plant is the mixing and coagulating tanks. This type of mixing tank was developed by the late William Gore and is usually referred to as the "Gore mixing tank." Previous to the construction of the Ottawa water purification plant two trial filters were erected there, chiefly with the object of

Fig. 11—Concrete Wash Water Troughs in Filter Unit.

developing better methods of coagulation previous to settling out and filtration. The results obtained from the operation of this plant are fully described in a paper entitled "The Trial Filtration Plant, Ottawa, Canada" by George G. Nasmith.[2] The method as now worked out

[2] Volume 22, No. 8 of the Journal of the American Water Works Association.

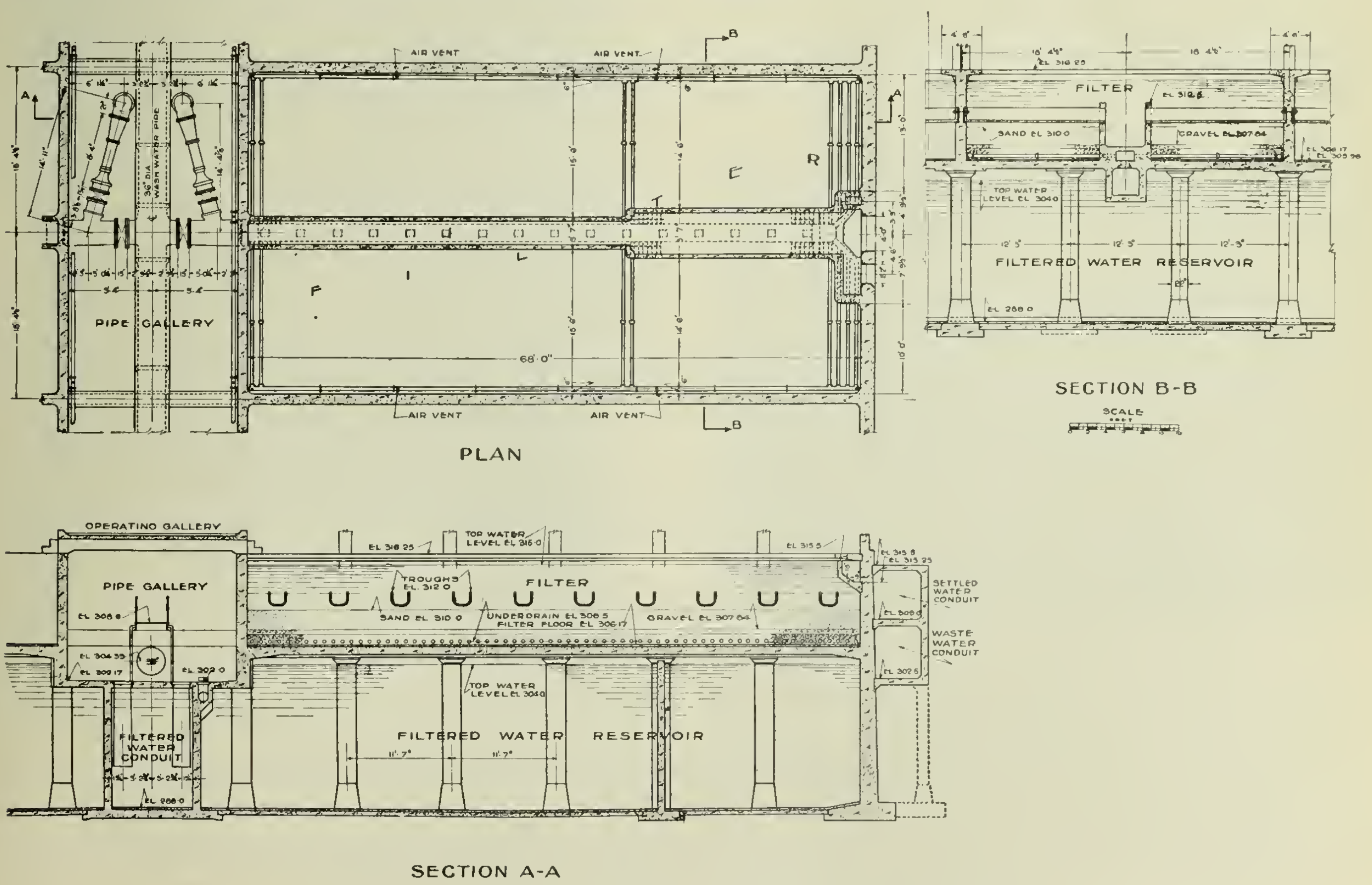

Fig. 10—Typical Filter, Victoria Park Water Purification Plant.

has proved exceptionally efficient and for several years has been in operation at Ottawa, Calgary, Belleville and St. Thomas. For the maximum rate of flow the mixing tanks have a capacity for forty minutes' treatment and the settling tanks for two hours and fifty minutes. The combined mixing and settling tanks are three in number, each 389 feet 3 inches in length, 90 feet in width and a depth of 23 feet 8½ inches. Each mixing chamber is 90 feet

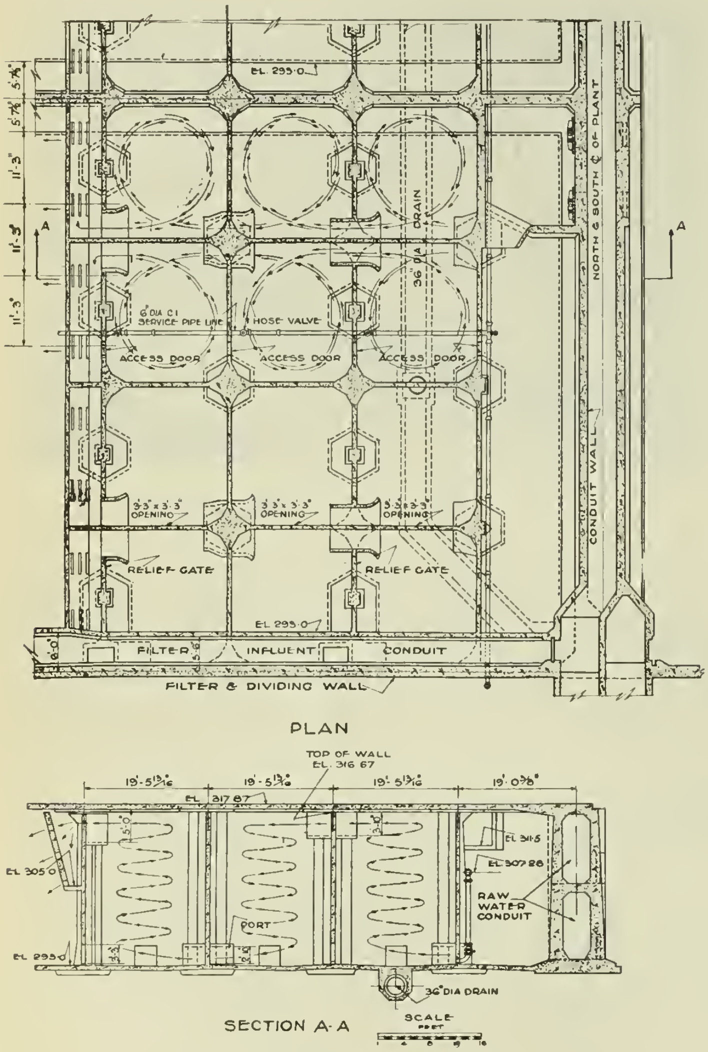

Fig. 12—Mixing Chambers.

in width and 73 feet in length, divided into twelve separate compartments. This part of the plant was designed to produce a very gentle stirring action and distribute the flocculated water into the settling tanks without breaking up the floc which is extremely fragile. Short circuiting was reduced to a minimum by dividing the process into several stages and by the special design of the passages. The raw water after treatment with the necessary chemicals is brought to the settling tanks by a concrete conduit running along the easterly wall. From this conduit the water enters the mixing chambers and the direction of flow from one compartment to another changes until the water finally reaches the settling tank as shown in Fig. 12. The coagulation obtained in these chambers is most effective and the total loss of head in passing through the various compartments will be about four inches at normal capacity. Figures 13 and 14 show inside views of the mixing chambers and settling tanks.

The administration building, situated in the centre of the final development, contains, besides the administrative offices, a fully equipped laboratory with all the necessary apparatus for controlling and directing the water purification operations.

Reservoir Leakage Test

On top of the concrete floor of the reservoir a waterproof membrane was placed consisting of a layer of asphalt-saturated asbestos mopped with a coating of asphalt waterproofing cement using 30 pounds of such cement for each 100 square feet, and while still hot a layer of asphalt-saturated fabric was embedded in it. The surface of this saturated fabric was again mopped with a coating of waterproofing cement and while still hot a layer of asbestos felt laid at right angles to the fabric with joints lapped 3 inches was embedded in it. Over the surface of this felt a coating of waterproofing cement was placed. Once this had been completed and allowed to set thoroughly, a two-inch layer of concrete was placed throughout the entire reservoir floor.

Under the contract a leakage test was carried out extending over a period of five days. The permissible invisible leakage during the test was not to exceed 60 Imperial gallons per minute. The total floor and wall area of the reservoir subject to leakage is about 174,000 square feet and the test showed that the total leakage during one hundred and twenty hours was 6,160 gallons or somewhat less than one Imperial gallon per minute.

Pumping Stations

The pumping station to be constructed at Victoria Park will be an all-electric station without auxiliary power of any kind other than a relatively small supply obtained

Fig. 13—Outlet Section of Mixing Chambers.

from storage batteries which will be available at all times for the automatic operation of switching equipment and for certain emergency lights, selsyn motor and synchronous clock circuits. The pumping station will contain the low lift pumps which will pump raw water to the filter plant and the high lift pumps which will pump filtered water into the distribution system. Also included in the station will be the wash water pumps.

The pumping station structure is to be 295 feet in length by 84 feet in width and is divided into four parts, the intake and screen section, low lift pump section, high lift pump section and administrative and control section. In addition to the pumping station proper there are several valve and meter chambers with interconnecting galleries and a very substantial group of service buildings comprising the chemical plant, heating plant, transformer station, workshops and stores, the location and extent of which are evident from a study of Fig. 9.

Fig. 14—Settling Basin Looking Towards Mixing Chambers.

The intake and screen section of the pumping station is built directly over the intake shore shaft and will contain four and ultimately eight mechanically operated travelling screens through which the incoming water will pass to two 84-inch suction headers. Each of the screens is contained in a separate compartment which can be isolated by electrically operated sluice gates. In the construction of the screen section provision is made for a surge overflow duct which will adequately handle any surge that may be caused by sudden stoppage of the raw water pumps due to failure of the power supply.

The low lift pump section will in the beginning contain four synchronous-motor-driven, single-stage, centrifugal pumps having capacities of 50, 40, 25 and 20 million Imperial gallons per day, respectively, against a total head of 82 feet. In addition to the provision of space for two future pumping units the piping for all pumps is designed on the basis of 50,000,000 gallons capacity to provide for ultimate requirements.

The high lift pump section will contain two synchronous-motor-driven, two-stage, centrifugal pumps each having a capacity of 12,000,000 gallons daily against a net head of 191 feet, and two units of similar type each having a capacity of 18,000,000 gallons per day against a net head of 260 feet. The former units are for pumping filtered water into No. 1 District of the distribution system and the latter units will serve No. 5 District of the distribution system (see Fig. 1). In addition the high lift section will contain three induction-motor-driven, single-stage, centrifugal pumps for pumping filtered water to the wash water tanks in the filter plant to be used for back-washing the filters. These pumps will have capacities of 10, 7½ and 5 million gallons daily, respectively, against a total head of 54 feet.

The discharge pipe line from each of the raw water pumps will contain a Venturi meter and all such meters are placed in a meter gallery which lies between the pumping station proper and the chemical plant. Beyond these meters the raw water discharge pipes are merged in two groups into two 84-inch conduits leading to the filter plant. Each of these conduits is equipped with a controller valve, the purpose of which is to automatically maintain the level of water in the settling basins within predetermined limits.

The discharge pipe lines from each of the high lift pumps will contain combined automatic stop, check and throttle valves, Venturi meters and surge suppressors.

In the equipment of the pumping station a very extensive and modern system of remote indication and control is provided for. For instance the rate of flow as measured by the individual Venturi meters on the raw water pumps will be electrically totalized to control automatically the application of chemicals to the raw water. Also the rate of flow indicated by each individual Venturi meter, the degree of valve opening, suction and discharge gauge pressures, will be remotely indicated on dials in the pump control cabinets set on the pump room floor and also, in some cases, on similar instruments mounted on the main switchboard in the control room. In addition to the valves meters and gauges directly connected with each pumping unit, other main valves used in connection with the operation of the plant, various water level gauges, and the 84-inch Venturi meter which will measure the filtered water being drawn by the combined John street and Parkdale pumping stations will be equipped with remote indicating devices mounted in the main control room.

As previously stated the Victoria Park pumping station is designed solely as an all-electric station without standby power of any other kind. In consequence of this the whole electrical installation from "incoming" lines to distribution busses, inclusive, is to be completed in duplicate with the most modern equipment and protective devices obtainable to ensure the minimum interruption to service. Power will be furnished by the Toronto Hydro-Electric System at 13,200 volts from the Carlaw avenue and the Danforth avenue substations and will be brought to the transformer station at Victoria Park over two underground cables. Provision is also made at this substation for a third "incoming" line. At Victoria Park power will be transformed from 13,200 to 2,300 volts.

Fig. 15—Filtered Water Conduit in Reservoir.

The main switchboard in the control room is of the bench board type with dummy bus and push button control. The electric installation includes auto transformers for reduced voltage starting and motor generator exciter sets for field current. The switching equipment is so arranged that the synchronous motors will start on reduced voltage and when up to approximately synchronous speed will automatically be thrown on full voltage and the field applied. The rheostats in connection with the exciter sets will be motor operated from the bench board.

The discharge valves from the eleven pumps and the two regulating valves may be opened or closed or otherwise controlled from the bench board in the control room. Also the position of each valve so controlled, the rate of flow, gauge pressures and water levels are all transmitted to, and indicated on, this board. In addition to the main bench board the control room contains a relay board and service board. A further transformation from 2,300 to 550 volts is made in the pumping station to provide 550-volt power for drainage pumps, cranes, travelling screens and various other equipment, the distribution of which is controlled from the service board.

It is intended to provide metal clad switch gear for all 13,200- and 2,300-volt switches and oil disconnects.

The Parkdale pumping station in general follows the requirements laid down for the Victoria Park pumping station except that there will be no pumps of the low lift type.

Chemical Treatment

The chemical plant is designed to contain a reasonable storage of alum having in mind an ultimate capacity of 200,000,000 gallons daily. Alum will be delivered to the plant in bags by trucks and will be handled by pneumatic conveying equipment into the storage bins. From the storage bins it will be drawn by gravity into weight hoppers furnished in connection with the dry feed chemical machines. Two such machines are to be installed at present for alum and a third machine which may be used for activated carbon or such other chemicals as may be required in the future. From the solution chambers of the chemical machines the solution will flow by gravity and be applied to the incoming raw water at the intake well.

Each of the two storage bins has capacity for 140 tons of alum. It is estimated that the dosage of alum applied to the raw water will average 0.5 grains per gallon and will not exceed 1.5 grains per gallon.

St. Clair Reservoir

The first actual work to be placed under construction and put in service was the St. Clair reservoir to take care of District No. 2. This reservoir has a capacity of 50,000,000 gallons, is built of reinforced concrete throughout, the roof being supported on columns. The flat slab roof has the 3-way system of reinforcing and is 10 inches in thickness. The earth fill to a depth of 2 feet has been sodded over and a most serviceable park for the use of the citizens is available at all times. Tennis courts and other outdoor recreations are in full swing particularly in the summer months. The reservoir is divided into two compartments of equal capacity. Figure 17 gives typical cross sections through the outer wall, dividing wall and columns. There are 830 columns supporting the roof. The columns are spaced at 21 feet 6 inches centres and the reservoir has a water depth of 23 feet. The volume of concrete placed amounted to 42,452 cubic yards. The total cost of the reservoir, excluding land and engineering, was $884,395, which works out at approximately $17,688 per million gallons capacity.

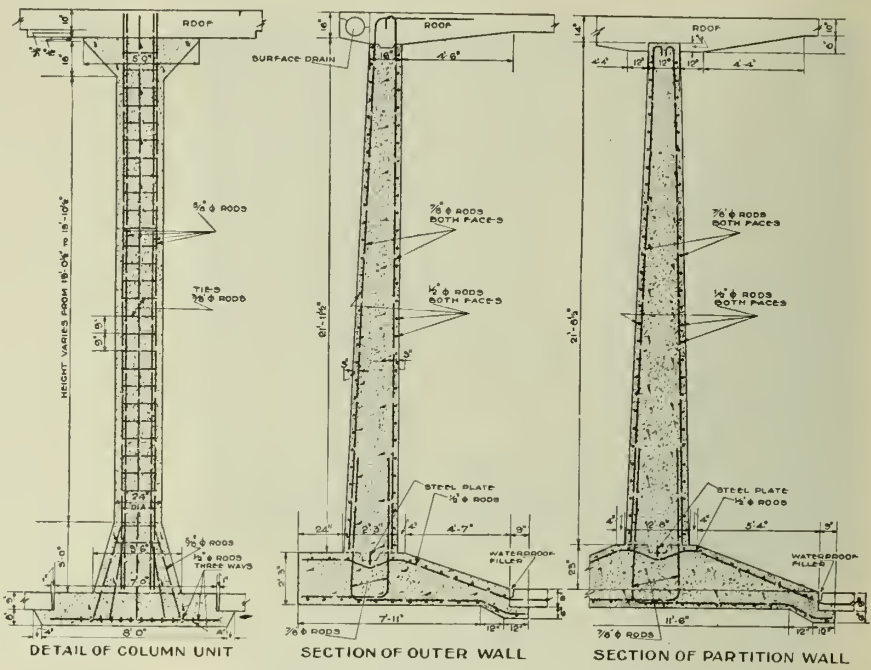

Fig. 17—St. Clair Reservoir, Concrete Details.

St. Clair Overhead Tank

Plans have been prepared for the erection on the same site of an enclosed steel overhead storage tank having a capacity of 536,000 gallons to serve District No. 3. In keeping with the surroundings this tank is of an ornamental type as shown on Fig. 18. The concrete piers for supporting the tank were built on a ring footing which was constructed a few feet below the original ground surface. The earth fill at this part of the reservoir embankment

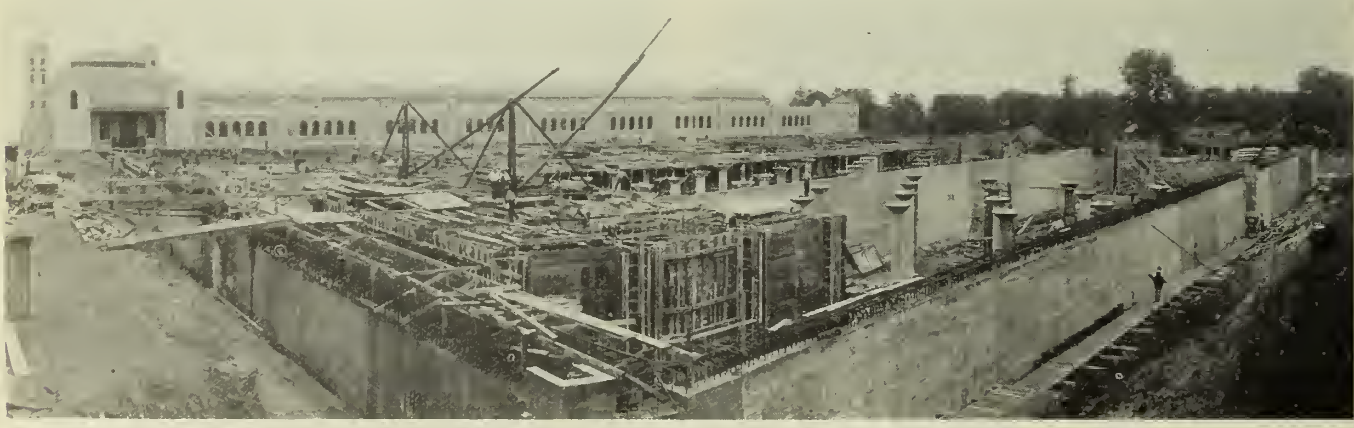
Fig. 16—Northerly Elevation of Victoria Park Filter House, Mixing and Settling Tanks in Foreground.

is about 29 feet in depth and to curtail the total load on the hill the piers were connected by a circular wall and the enclosure was left unfilled. The tank is 45 feet inside diameter with a maximum depth of 65 feet supported on 12 steel columns and having a riser pipe 8 feet in diameter. The overflow pipe is 14 inches in diameter and access openings are provided on the roof and at the base of the riser pipe. The structure is designed to withstand safely the weight of the steel tank, the weight of the buildings surrounding the structure, the weight of the water in the tank, wind stresses caused by a hurricane blowing at the rate of 100 miles per hour from any direction and the snow load on the roof of the tank. Stresses caused by emptying and subsequent filling of the tank in a space of thirty minutes were taken into account in designing the structure. The tank bottom is of the elliptical type with a depth of the elliptical section of 15 feet. All structural steel columns, beams, brackets and the overhead tank including roof and riser pipe (inside and outside) are to be coated with gunite 1½ to 2 inches thick.

In general the building is to be faced with brick of first quality grey stock with stone base, pilasters and trim cut from the best quality Queenston limestone. The total cost of the overhead tank excluding land is estimated to be $120,000.

Conclusions

On the completion of the waterworks extensions Toronto will have available a water supply capable of taking care of a population of 1,000,000 persons and so laid out as to permit of extensions being made whenever required to supply 1,500,000 persons. The extensions everywhere contain the most up-to-date equipment and every known precaution has been taken to ensure the safety and continuity of the supply. To adequately safeguard the raw water supply the city council has under consideration extensive additions to the sewage disposal works, the effluent from which at the present time discharges into Lake Ontario about midway between the existing Centre Island intakes and the new intake at Victoria Park.

Engineering

The whole project is being carried out under the direction of R. C. Harris, Commissioner of Works, with George G. Powell as deputy city engineer, and the late James Milne, M.E.I.C., and latterly A. U. Sanderson, A.M.E.I.C., as chief engineer of the Water Supply Section.

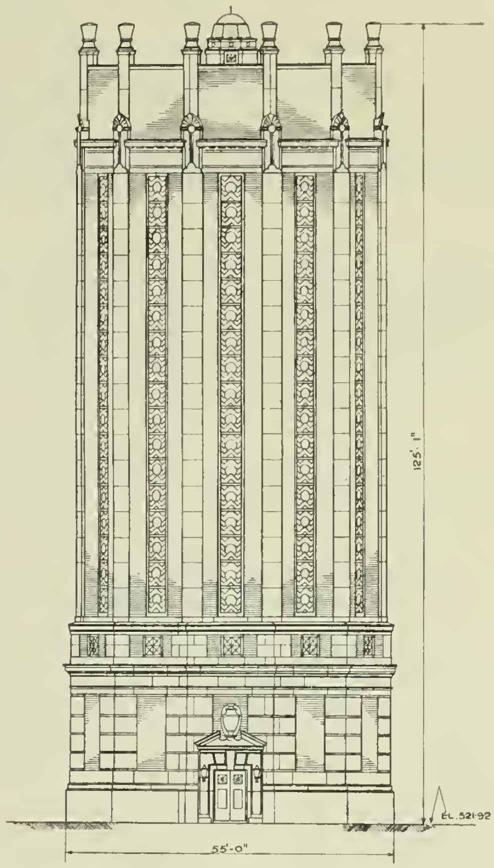

Fig. 18—Water Tower for District No. 3.

The design of the works, the supervision of construction and the operation for a period of one year after placing the works in service is being carried out by H. G. Acres and Company, Limited, and Gore, Nasmith and Storrie, joint consulting engineers on the work

Simple Graphical Solution for Pressure Rise in Pipes and Pump Discharge Lines

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY.—Dealing with the problem of finding the pressure changes in a pipe line, caused by changes in the flow of water, the author explains a graphical method of calculation based largely on the work of Allievi. A number of numerical examples are worked out, involving the effect of rate of gate-closure, resonance, surge-tank action, and supply by a motor driven centrifugal pump.

The problem of finding the pressure change in a pipe line where there is variable flow produced, for example, by altering the opening in a discharge valve, has always been an important one and frequently very baffling. Where the pipe is uniform in size, the solution is much simpler than in the case of tapering pipes, and the addition of branches from the main line greatly complicates the problem.

The names of Joukovsky and Allievi will always be associated with this problem, the former engineer having done a lot of fundamental experimental work and established the general theory and certain fundamental equations. Lorenzo Allievi,(1) still living in Rome, greatly simplified the work previously done and prepared many very important diagrams and charts for the solution of certain types of problem. Allievi's book was written in Italian, later translated into German and into French, but did not exist in English till 1925 when Mr. Eugene Halmos(2) of New York translated the work under the title "Theory of Water Hammer, Notes I to V"; this edition was printed in Rome and contains a number of errors in spelling and grammar (but few in mathematics) and many curious and unusual phrases; yet the author of this paper never read anything of any kind that so thrilled and pleased him, as he saw the elegance and completeness with which Professor Allievi had mastered his subject. The book is a masterpiece, extremely simple and logical and must be regarded as the basis of modern work on this subject.

Notwithstanding all the merit Allievi's book possesses, it is not much read by engineers, most of whom lay it aside because they think it contains too much mathematics. The entire mathematical difficulty in the work is due to two equations established by Allievi from hydrodynamics, which may be readily verified and which are actually unwittingly used by all persons solving problems on water hammer. Before proceeding further, these equations must be explained. In Fig. 1 the simplest case is shown, where a pipe of uniform diameter discharges through a nozzle, or valve or turbine gate, or other similar device. Friction will first be neglected, as is usual, and because it produces very small effects in most of the cases discussed herein.

The symbols used throughout the paper are tabulated below for convenient reference.

The words "gate," valve," "nozzle" have the same meaning and refer to the device at the discharge end of the pipe, by which velocity changes are made.

A_P = Area of pipe, square feet, assumed uniform.
A_1 = Area through gate or nozzle or valve, square feet.
A_E = Effective area in square feet through gate = $A_1 \times$ coefficient of discharge c_d.
$G = \frac{A_E}{A_P}\sqrt{2g}$ and varies only with A_E.
c_d = Coefficient of discharge.
Q = Discharge through pipe at any instant, cubic feet per second.
v = Velocity in pipe at any instant, feet per second.
u = Demand velocity in problem on surge tank, feet per second.
v_{Bt}, etc. The notation is similar to that for H.
a = Velocity of the pressure wave in the pipe, feet per second.
H = Head in feet (not including velocity head) in pipe close to gate, or at the point and time indicated by the subscript used with it.
H_{Bt}, etc. = Pressure in feet at the point B at t seconds after gate movement begins. Thus, $H_{A3.2}$ is the pressure in feet at the gate end of the pipe 3.2 seconds after the gate is first moved.
h = Instantaneous pressure rise (or fall) in feet due to a small gate movement.
F = Sum in feet of all the instantaneous direct pressures up to any instant.
f = Sum in feet of all the instantaneous reflected pressures. It has been written with a plus sign but is numerically negative.
l = Length of pipe, in feet.
x = Distance from the gate to the section under consideration, feet.
t = Time in seconds after gate movement begins, at which the events occur.
$X = v/v_0$ and $Y = H/H_0$ at the point and time designated by the subscript used.
$A\,3.2$ on the diagram is a point showing the pressure and velocity at the gate end of the pipe 3.2 seconds after the gate begins to move, and so on for other points.
A, B, C are points on the pipe line at the valve end, at an intermediate point and at the reservoir end, respectively, unless otherwise stated.

The subscript zero placed after any of the above symbols denotes the value at steady pipe flow, and before gate motion begins.

$\rho = \frac{av_0}{2gH_0}$ the pipe line characteristic of Allievi.

At any instant after gate movement begins, let the discharge be Q cubic feet per second, which corresponds to a head H feet at the nozzle; and if at this instant the pipe and gate areas are A_P square feet (assumed uniform from end to end of the pipe) and A_1 square feet, respectively, then the corresponding velocities will be v feet per second and u feet per second, respectively, in the pipe and from the nozzle.

Now let $A_E = A_1 c_d$ be the effective nozzle area, by which is meant the actual discharge area multiplied by a suitable coefficient of discharge. Let the quantities corresponding to the above, for steady motion (that is, before gate movement begins) be Q_0, H_0, A_P, A_{E0}, v_0 and u_0, respectively.

For the exact explanation of what happens in the pipe during gate movement, the reader is referred to standard textbooks and papers, such as the author's "Hydraulics for Engineers"(3) and numerous papers, amongst which may be specially mentioned those by N. R. Gibson(4) and Miss

(1)Numbers refer to bibliography at end of paper.

O. Simin.[5] The author sees no justification for repeating here the explanation given in those publications.

Briefly, it may be stated that when any slight closing movement of the gate occurs it extinguishes a part δv of the velocity, and causes a momentary rise in pressure h feet to travel from the gate up to the reservoir and back again at a velocity of a feet per second, the time interval required for the complete travel of this wave being $2l/a$ seconds, where l is the pipe length in feet. When this wave of positive pressure returns to the gate it is reflected as a

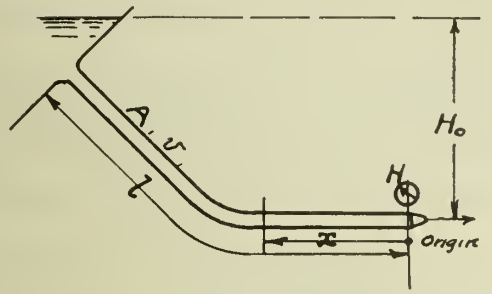

Fig. 1

negative wave of equal magnitude, and this process continues till it finally dies out through friction. It is easy to show (see articles already referred to) that the relation between the quantities is

$$h = \frac{a}{g} \cdot \delta v \qquad (1)$$

This is Joukovsky's relation.

Referring now to Fig. 1, the following relations are evident, for any given interval:

$$Q = A_P v = A_E \sqrt{2gH}$$

or, at any instant

$$v = \frac{A_E}{A_P}\sqrt{2gH} = G\sqrt{H} \qquad (2)$$

also, before movement begins

$$v_0 = \frac{A_{E0}}{A_P}\sqrt{2gH_0} = G_0\sqrt{H_0} \qquad (3)$$

Hence $$\frac{v}{v_0} = \frac{G}{G_0}\sqrt{\frac{H}{H_0}} = E\sqrt{\frac{H}{H_0}} \text{ where } E = \frac{G}{G_0} \qquad (4)$$

To determine the change of velocity and the corresponding pressure rise due to any gate movement, the two equations (1) and (2) are available and are most easily solved by a trial and error process. For the first pressure wave it is evident that

$$v = G\sqrt{H} = G\sqrt{H_0 + h}$$

and G is known from the method of moving the gate. For any later period after several movements of the gate, the equations are the same, G being known as already explained, but the h to be used is the algebraic sum Σh of all the pressure changes, positive and negative, up to the time considered, or

$$v = G\sqrt{H_0 + \Sigma h} \qquad (5)$$

An example taken from the author's textbook is given here for illustration. The water in a pipe 643 feet long has a steady velocity, with open gate, of 14.44 feet per second, under a head $H_0 = 400$ feet, and the valve at the discharge end of it is assumed to close in such a way that its effective area decreases uniformly with time; that is, there is a straight line relation between A_E and the time reckoned after gate motion begins. The velocity of wave travel $a = 3{,}800$ feet per second has been used. It is desired to find the pressure changes in the pipe.

The two equations give corresponding values of H and v at the gate, which satisfy them; and the method is assumed to be well enough known to require no detailed explanation. For the case mentioned, the results are shown in Fig. 2, the actual pressures being taken directly from the author's textbook. In the illustration, the pressure waves are shown by single lines instead of by the typical diagram for the first gate movement at (a) Fig. 2; in the single line pressure-wave diagram at (b) Fig. 2, the heavy lines indicate the direct or positive waves, while the light lines indicate the negative or reflected waves.

Below the pressure-wave diagram (b) there are shown at (c) the sums of all the positive or direct pressures up to each time given, these being designated by F on the diagram; at (d) are shown the sums of all the negative or reflected pressures, designated by f, up to the time given; at (e) are plotted the algebraic sums of the positive and negative pressures, which are simply the sums $F + f$, and as f is always negative these are really numerical differences; at (g) are the algebraic differences of the positive and negative pressures, and for the reason just stated these are numerical sums.

The above diagrams give pressures at the gate, but if similar information is desired at another point on the pipe, then corresponding pressure diagrams may be drawn for that point; e.g. the one for the centre of the pipe cor-

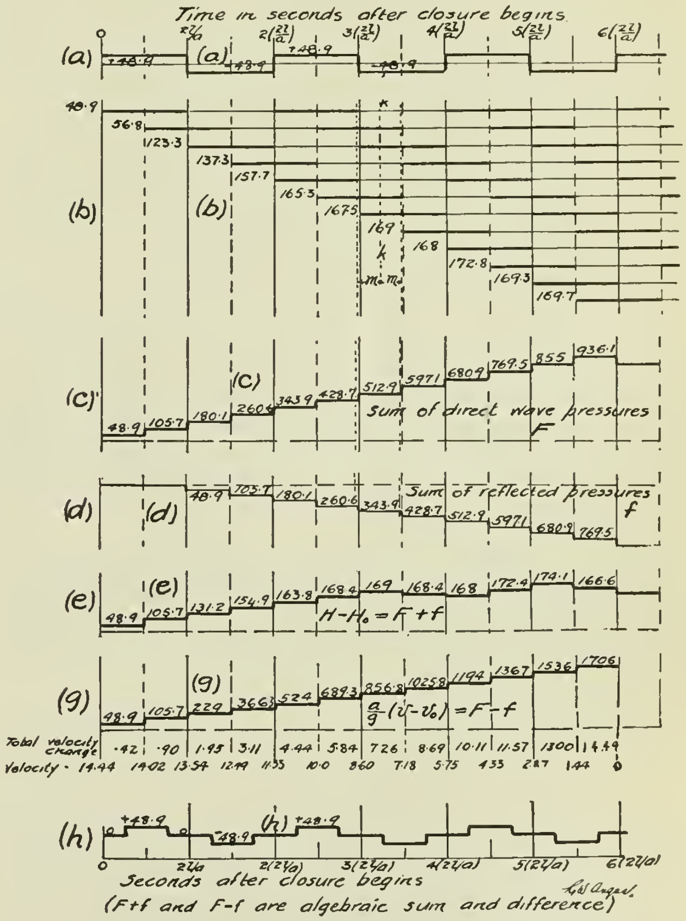

Fig. 2—Pressure Wave Curves for Pipe 643 Feet Long.

$a = 3{,}800$ ft. sec. $v_0 = 14.44$ ft. sec. $H_0 = 400$ ft.

Closure Time $T = 6\left(\frac{2l}{a}\right)$ sec.

responding to the first movement of the gate is shown at (h) on Fig. 2. This is the diagram for the centre of the pipe at a time $l/2a$ seconds later than the corresponding diagram at the gate, since the pressure rise produced at the gate takes $l/2a$ seconds to reach the centre of the pipe. By drawing the series of pressure diagrams for the centre of the pipe for each gate movement, as has been done for the gate end at (b) Fig. 2, the pressure at any instant is easily found by the method already described, and well known as arithmetic integration.

With these preliminary statements, Allievi's equations, as given by Halmos,(2) may now be stated, and should be easily understood from the illustrations which follow.

ALLIEVI'S EQUATIONS

$$H - H_0 = F\left(t - \frac{x}{a}\right) + f\left(t + \frac{x}{a}\right) \ldots\ldots\ldots\ldots (6)$$

$$v_0 - v = \frac{g}{a}\left[F\left(t - \frac{x}{a}\right) - f\left(t + \frac{x}{a}\right)\right] \ldots\ldots\ldots (7)$$

$$H_n + H_{n-1} - 2\,H_0 = \frac{a}{g}(v_{n-1} - v_n) \ldots\ldots\ldots (8)$$

The origin for distance is taken at the gate and x is the distance (measured towards the reservoir) at which the pressure is H feet at t seconds after closure begins, the velocity corresponding to H being v feet per second.

The quantity $F\left(t - \frac{x}{a}\right)$ is the sum of all the direct or positive pressures at time t and at a point x feet from the gate. The sums of these pressures at the gate, where $x = 0$, are given at (c) Fig. 2; in this case $F\left(t - \frac{x}{a}\right) = F(t)$, which in that figure is denoted by F. Similarly, $f\left(t + \frac{x}{a}\right) = f(t)$ at the gate, which is denoted by f in Fig. 2 at (d).

In the case shown, these summations are made for each half interval, and this is desirable in any case, and is absolutely essential if the pressure at the centre of the pipe is to be found; it would be necessary to make the calculation for each quarter interval if the pressure at $\frac{1}{4}\,l$ or $\frac{3}{4}\,l$ from the gate was desired.

For the centre of the pipe $x = l/2$ and

$$F\left(t - \frac{x}{a}\right) = F\left(t - \frac{l}{2\,a}\right) \text{ also } f\left(t + \frac{x}{a}\right) = f\left(t + \frac{l}{2\,a}\right),$$

so that at any instant t after closure begins, one would take the algebraic sum (numerical difference) of the direct pressures $l/2\,a$ seconds earlier, and of the reflected pressures $l/2\,a$ seconds later, which is easily done by means of diagrams (c) and (d) Fig. 2. The dotted line kk corresponds to $t = 6.5\,l/a$ and the additions and subtractions are taken at the lines distant m from kk.

A little reflection will show that these formulæ of Allievi only express in algebraic manner the process actually carried out arithmetically in the example given above, as is shown by the following illustrations:

(a) *A point at the gate end of the pipe where* $x = 0$.

(1) At $t = 3\left(\frac{2\,l}{a}\right)$ seconds after closure begins, the pressure rise is clearly $F(t) + f(t)$, or the sum of the two curves (c) and (d) in Fig. 2 at time $t = \frac{6\,l}{a}$; i.e. $H_3 - H_0 = 428.7 + (-\,260.6) = 168.1$ feet (curve e) and so on for all times desired.

Then $H_3 = H_0 + 168.1 = 568.1$ feet.

(2) At the same time $t = 3\left(\frac{2\,l}{a}\right)$ seconds the velocity change is

$$\frac{g}{a}[F(t) - f(t)] = \frac{32.16}{3800}[428.7 - (-\,260.6)]$$
$$= 5.84 \text{ feet per second}$$
$$= v_0 - v_3 \text{ (curve } g\text{)}$$

or $v_3 = 14.44 - 5.84 = 8.60$ feet per second.

(3) $H_3 + H_2 - 2H_0 = 568.1 + 554.9 - 2 \times 400 = 323$ feet for the third interval, and $(g/a)\ 323 = 2.73$ feet per second; it may be shown that this is the same as is found by the arithmetic method already referred to. H_2 and H_3 are the pressures at the ends of the second and third phases, respectively.

(b) *A point at centre of pipe for the same pressure wave.*

Here $x = l/2$ and the time $t + \frac{l}{2\,a}$ seconds after closure begins, corresponds to t at the gate.

(1) At $t = 3\left(\frac{2\,l}{a}\right) + \frac{l}{2\,a}$ seconds after closure begins, it is readily seen, by drawing the pressure diagrams like (h) Fig. 2, for this point, that the pressure rise is 84.8 feet. Equation (6) would give $H - H_0 = 428.7 - 343.9 = 84.8$ feet, the dotted line k corresponding to the time $3\left(\frac{2\,l}{a}\right) + \frac{l}{2\,a}$ and the distances m being equal to $\frac{l}{2\,a}$ seconds, so that F and f are easily read off.

(2) At the same time the velocity change is, by equation (7), $v_0 - v = \frac{g}{a}\,[428.7 + 343.9] = 6.54$ feet per second or $v = 7.90$ feet per second.

If the reader will take the trouble to actually draw the complete set of pressure diagrams and carry out the calculation by arithmetic integration, he will very soon be convinced of the accuracy of the equations (6), (7) and (8). While equation (8) applies only to pressure rise at the ends of two successive intervals, equations (5) and (6) apply to any point on the pipe, and at the reservoir end where $x = l$ the pressure rise is zero because the values on curve (d) at any instant are the same as those on curve (c) at a period $\frac{2\,l}{a}$ seconds earlier. Familiarity with the meaning of these three equations makes the rest of this paper relatively simple, and indeed, makes it easy to read almost any article on water hammer.

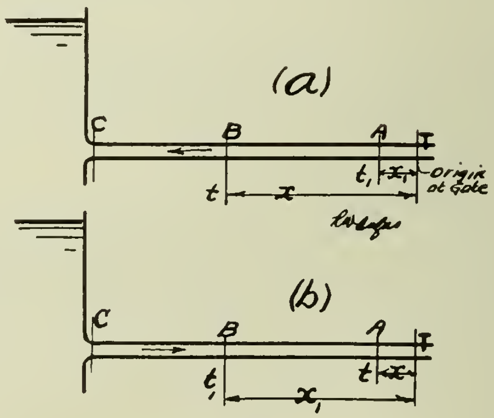

Fig. 3

Taking now Allievi's equations (6) and (7), just discussed, and adding them, gives:

$$H - H_0 = -\,\frac{a}{g}\,(v_0 - v) + 2\,F\left(t - \frac{x}{a}\right) \ldots\ldots\ldots (9)$$

and by substracting them

$$H - H_0 = +\,\frac{a}{g}\,(v_0 - v) + 2\,f\left(t + \frac{x}{a}\right) \ldots\ldots\ldots (10)$$

where H and v are corresponding values for any point x feet from the gate, t seconds after closure begins. Selecting two sections A and B on the pipe, as shown on Fig. 3 (a), equation (9) gives

$$H_{Bt} - H_{B0} = -\frac{a}{g}(v_{B0} - v_{Bt}) + 2F\left(t - \frac{x}{a}\right) \ldots\ldots\ldots (11)$$

$$H_{At1} - H_{A0} = -\frac{a}{g}(v_{A0} - v_{At1}) + 2F\left(t_1 - \frac{x_1}{a}\right) \ldots (12)$$

Where the pipe is of uniform size throughout, $v_{A0} = v_{B0}$ and if, as is most usual, the velocity heads are small relative to the pressure heads, then $H_{A0} = H_{B0}$.

Again, a pressure wave takes $\frac{x - x_1}{a}$ seconds to travel from A to B, so that if events for B are reckoned at a time $\frac{x - x_1}{a}$ seconds later than those for A the very same pressure wave will be under consideration in both cases. But this condition evidently means $t - t_1 = \frac{x - x_1}{a}$ or $t - \frac{x}{a} = t_1 - \frac{x_1}{a}$ or $F\left(t - \frac{x}{a}\right) = F\left(t_1 - \frac{x_1}{a}\right)$.

Therefore with the assumption made as to the times, the subtraction of equation (12) from (11) results in

$$H_{Bt} - H_{At1} = +\frac{a}{g}(v_{Bt} - v_{At1}) \ldots\ldots\ldots\ldots\ldots (13)$$

For the reflected wave, equation (10) when treated in a similar manner gives (see Fig. 3 (b)):

$$H_{Bt1} - H_{B0} = +\frac{a}{g}(v_{B0} - v_{Bt1}) + 2f\left(t_1 + \frac{x_1}{a}\right) \ldots\ldots (14)$$

$$H_{At} - H_{A0} = +\frac{a}{g}(v_{A0} - v_{At}) + 2f\left(t + \frac{x}{a}\right) \ldots\ldots\ldots (15)$$

For the reasons already stated, times are reckoned so that $t - t_1 = \frac{x_1 - x}{a}$ or $t + \frac{x}{a} = t_1 + \frac{x_1}{a}$ from which (14) and (15) give

$$H_{At} - H_{Bt1} = -\frac{a}{g}(v_{At} - v_{Bt1}) \ldots\ldots\ldots\ldots\ldots (16)$$

If three points on the pipe are being studied, then calling them A, B and C and assuming them located as in

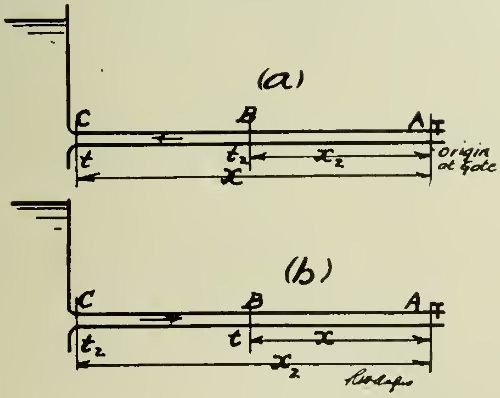

Fig. 4

Fig. 4, the following equations may be written, by the use of (13) and (16):

$$H_{Bt} - H_{Ct2} = -\frac{a}{g}(v_{Bt} - v_{Ct2}) \ldots\ldots\ldots\ldots\ldots (17)$$

$$H_{Ct} - H_{Bt2} = +\frac{a}{g}(v_{Ct} - v_{Bt2}) \ldots\ldots\ldots\ldots\ldots (18)$$

These equations may also be applied, if the pipes AB and BC are of different sizes, with the single change in the value of a, which is different for the two sections. It is assumed that the difference in velocity heads in the two sections is very small compared with H_0.

The four equations (13), (16), (17) and (18), together with a relation similar to (5) which establishes a connection between the law of gate motion, the head H, and the velocity v, are sufficient to solve all problems. To make the case clear, let a pipe 7,000 feet long be attached to a reservoir at C, discharging through a gate near A, and let it have a value of a = 3,000 feet per second. If now A, B and C are, respectively, 100, 2,000 and 7,000 feet from the origin at the gate, then the pressure wave travels from A to B in $\frac{2000 - 100}{3000} = 0.63$ second, and from B to C in $\frac{7000 - 2000}{3000} = 1.67$ second. Hence the four equations already derived, when applied to this case, would be

$$H_{B(t+.63)} - H_{At} = +\frac{a}{g}(v_{B(t+.63)} - v_{At}) \ldots\ldots\ldots (13)$$

$$H_{A(t+.63)} - H_{Bt} = -\frac{a}{g}(v_{A(t+.63)} - v_{Bt}) \ldots\ldots\ldots (16)$$

$$H_{B(t+1.67)} - H_{Ct} = -\frac{a}{g}(v_{B(t+1.67)} - v_{Ct}) \ldots\ldots (17)$$

$$H_{C(t+1.67)} - H_{Bt} = +\frac{a}{g}(v_{C(t+1.67)} - v_{Bt}) \ldots\ldots (18)$$

It is frequently convenient in work of this kind to get the values of H/H_0 and v/v_0 instead of H and v. To save letters, the former will be denoted by Y and the latter by X, as these are the axes on which the quantities are plotted later on.

From equation (13) by dividing by H_0 there results

$$\frac{H_{Bt}}{H_0} - \frac{H_{At1}}{H_0} = \frac{av_0}{gH_0}\left(\frac{v_{Bt}}{v_0} - \frac{v_{At1}}{v_0}\right)$$

Now the quantity $\frac{av_0}{2gH_0}$ has been designated by ρ by Allievi, who called this quantity the pipe line characteristic. For each pipe and condition of flow it has a fixed value which will appear later on as a most important factor in water hammer.

Using the above symbols with this equation gives

$$Y_{Bt} - Y_{At1} = +2\rho(X_{Bt} - X_{At1}) \ldots\ldots\ldots\ldots (19)$$

and by going through a similar transformation with the other equations (16), (17), (18), there results

$$Y_{At} - Y_{Bt1} = -2\rho(X_{At} - X_{Bt1}) \ldots\ldots\ldots\ldots (20)$$

$$Y_{Bt} - Y_{Ct2} = -2\rho(X_{Bt} - X_{Ct2}) \ldots\ldots\ldots\ldots (21)$$

$$Y_{Ct} - Y_{Bt2} = +2\rho(X_{Ct} - X_{Bt2}) \ldots\ldots\ldots\ldots (22)$$

These equations now enable any problem to be readily solved and will be made use of in the following illustrations. The value of a depends on the material of the pipe and its relative thickness, and for steel pipe the book[3] already referred to gives a formula $a = \frac{4660}{\sqrt{1 + 0.01\, d/b}}$ where d is pipe diameter and b is its wall thickness.

Graphical Construction

The graphical construction for solving these problems may now very easily be understood. For example, a uniform steel pipe 2,400 feet long, with a = 3,000 feet per second, is discharging freely through a gate under a head of 332 feet. Let the gate be closed so that its effective discharge area decreases uniformly with time, the total closure taking T = 4 seconds; the pressure rise at the gate is to be plotted on a time base.

For this pipe the time of travel of the pressure wave from the gate to the reservoir and back is

$$\frac{2 \times 2400}{3000} = 1.6 \text{ seconds,}$$

so that closure is in $T/1.6 = 2.5$ intervals.

Now the relation between the gate setting and the pipe velocity has already been established as $\frac{v}{v_0} = E\sqrt{\frac{H}{H_0}}$, equation (4), where E varies only with the gate setting, and is therefore dependent solely on the time elapsed after gate closure begins. With full gate $E = 1$, and one second after closure begins the value of $E = 0.75$, since the gate is one-quarter closed. These relations were explained earlier in the paper.

The diagram to be constructed has the axes shown in Fig. 5, and equation (4) will be represented on this diagram

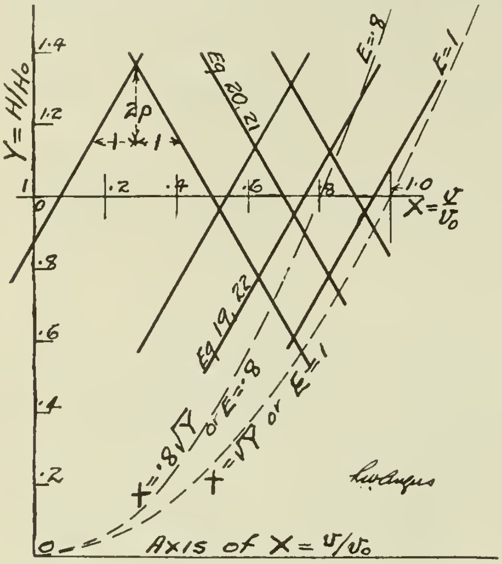

Fig. 5—Representation of Equations Used.

by a series of parabolas with vertices at 0. For full gate $E = 1$ and $\frac{v}{v_0} = \sqrt{\frac{H}{H_0}}$ and after the lapse of 0.8 second, or one-fifth of the total closing time, $E = .80$, or $\frac{v}{v_0} = 0.8\sqrt{\frac{H}{H_0}}$ and so on. These parabolas are very easily drawn by aid of a slide rule, and parts of two of them spaced 0.8 second apart are shown and marked $E = 1$ and $E = 0.8$.

Clearly on this diagram, equations (19), (22), (20) and (21) are represented by two series of parallel lines; the former two give lines with a slope whose tangent is $+ 2\rho$ and the latter two have tangents $- 2\rho$. Conditions at the reservoir are always represented by some point on the horizontal $Y = 1$ because there $H/H_0 = 1$, at least with a large reservoir, and if there is no friction in the line. Evidently the conditions at the gate are always shown on a parabola of the kind described and drawn with a suitable value of E.

Gate Closure

Proceeding now with the problem, the location of all points A, showing conditions at the gate end of the pipe, and of all points C showing those at the reservoir end, may be effected by using equations (19) and (20). Each point on Fig. 6 and all following diagrams is marked with a letter and a figure, the first corresponding to the point being considered, and the latter to the time after gate movement begins, at which the events at that point occur. Evidently points A_0 and $C\,.8$ are at $v = v_0$, $H = H_0$, because conditions at the reservoir end are not changed until 0.8 second later than at the gate end. The equations may then be written

$$Y_{A1.6} - Y_{C.8} = -2\rho\,(X_{A1.6} - X_{C.8}) \quad \ldots\ldots (20)$$
$$Y_{C2.4} - Y_{A1.6} = +2\rho\,(X_{C2.4} - X_{A1.6}) \quad \ldots\ldots (19)$$
$$Y_{A3.2} - Y_{C2.4} = -2\rho\,(X_{A3.2} - X_{C2.4}) \quad \ldots\ldots (20)$$
$$Y_{C4.0} - Y_{A3.2} = +2\rho\,(X_{C4.0} - X_{A3.2}) \quad \ldots\ldots (19)$$

In this way the points A and C at the beginning and end of each interval are determined and are shown on the upper diagram in Fig. 6. The drawing corresponds to the initial velocity $v_0 = 8$ feet per second, which gives $\rho = 1.125$. All points C are on the line $Y = 1$, since friction is being neglected.

Suppose now that it is desired to find the pressure at a point B located 0.25 l feet from A, then the time required for the pressure wave to travel from A to B is 0.2 second, and from B to C is 0.6 second, so that A_0, B 0.2 and C 0.8 are all located at one point. The line A 1.6 C 0.8 has already been located, and it is readily observed that A 0.4, A 0.8, A 1.2 are at the intersection of the parabolas E = .9, .8, .7 with this line. Further, the point B 1.4 coincides with A 1.2 because

$$Y_{A1.6} - Y_{B1.4} = -2\rho\,(X_{A1.6} - X_{B1.4}) \quad \ldots\ldots (20)$$
$$Y_{B1.4} - Y_{A1.2} = +2\rho\,(X_{B1.4} - X_{A1.2}) \quad \ldots\ldots (19)$$

The first of these lines coincides with A 1.6, A 1.2 and the second is a line through A 1.2 at slope $+ 2\rho$, so that B 1.4 coincides with A 1.2 and B .6 and B 1.0 are located as shown.

Again

$$Y_{C1.2} - Y_{B.6} = +2\rho\,(X_{C1.2} - X_{B.6}) \quad \ldots\ldots (22)$$

(this gives C 1.2)

and

$$Y_{B1.8} - Y_{C1.2} = -2\rho\,(X_{B1.8} - X_{C1.2}) \quad \ldots\ldots (21)$$
$$Y_{B1.8} - Y_{A1.6} = +2\rho\,(X_{B1.8} - X_{A1.6}) \quad \ldots\ldots (19)$$

(this gives B 1.8)

This process may be continued for all points.

The pressure diagram on a time base is also given in Fig. 6.

Gate Opening From Closed Gate

If the problem is to determine the drop in pressure due to quick opening of the gate, the method is exactly similar

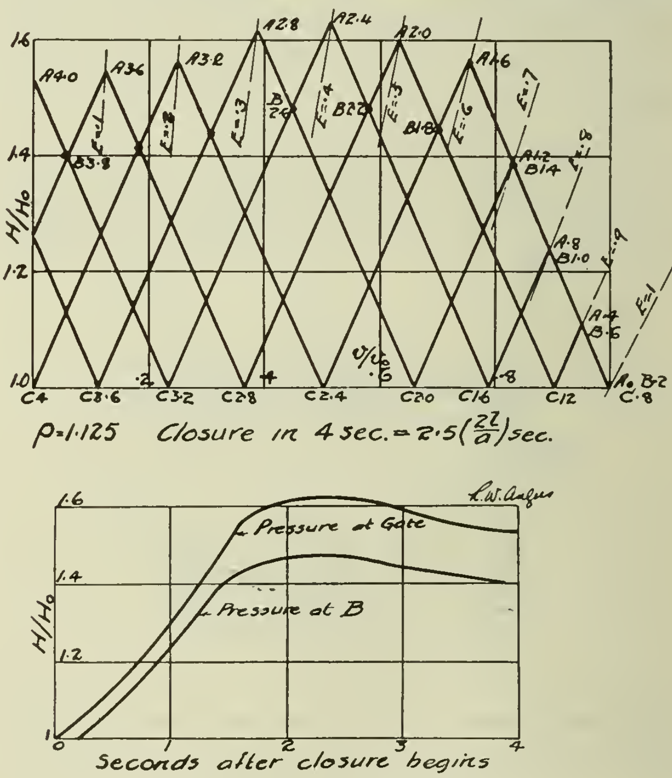

Fig. 6—Gate Closure in 4 sec.
$2\,l/a = 1.6$ sec. $\rho = 1.125$.

to the foregoing. Suppose, for example, that a pipe with a = 3,400 feet per second has a gate on the end of it that is quickly opened. The initial head H_0 = 317 feet, the final steady velocity for full gate is 6 feet per second, and the pipe is 3,400 feet long; it is assumed that the gate is fully opened in T = 4 seconds in such a way that the effective valve area increases uniformly with time. Evidently $2\,l/a = 2$ seconds and $\frac{aT}{2l} = 2$ intervals,

also $\rho = \frac{3400 \times 6}{2 \times 32.2 \times 317} = 1$ Friction is neglected.

Evidently this diagram (Fig. 7) starts at the top left corner, since $v = 0$ when $H = H_0$ just before gate movement begins. This problem will be worked out with ten equal gate movements, so that there are ten parabolas with $E = .1, .2, .3 \ldots 1.0$ drawn as shown on Fig. 7. Through the point A_0 the line A_0A_2 is drawn to represent equation (20), the tangent to its slope being $-\,2\,\rho$, then the points A .4, A .8, A 1.2, A 1.6 and A 2 give the pressure and velocity at A at 1/10, 2/10, 3/10, etc. of T, i.e. at 0.4, 0.8, 1.2 . . . seconds after opening begins. The line A 2-C 3 representing equation (19) gives the velocity at the reservoir end at 1.5 intervals after opening begins, and finally equation (20) represented by the line C 3-A 4 gives the point A 4 corresponding to the pressure and velocity at the instant the gate is fully open.

At the four-tenths of the intervals the conditions at the gate are represented by A .8, A 2.8, and so on for other points. The pressure diagram on a time base is also plotted at the right of Fig. 7. It is to be noted that the pressure oscillations do not cease the instant the gate is fully open, but their actual values may be found by continuing the construction already described, only that now all points corresponding to the pressure at the gate end must be on the parabola $E = 1$, since the gate is fixed. The pressures quickly die out as would be found from the diagram.

Gate Opening From Part Gate

If the gate is partly open under steady flow and is then quickly moved to the wide open position, the pressure and velocity changes are found in a similar way to the preceding case. For example, a pipe (a = 3,470 feet per second) working at normal static head of 90 feet, is discharging with a velocity of 2 feet per second with partly open gate, it is required to find the velocity and pressure changes at the gate when the latter is opened at uniform rate so as to produce a final steady pipe velocity of 5 feet per

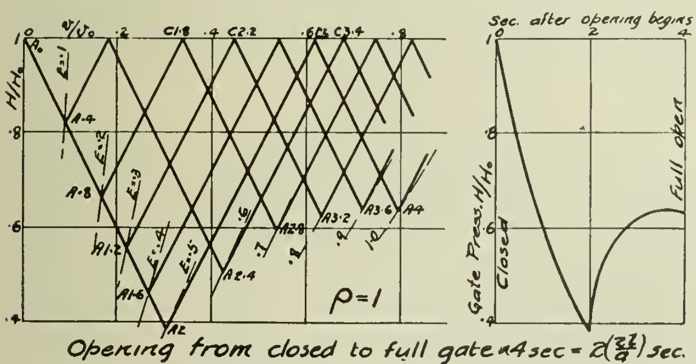

Fig. 7—Gate Opening.
$\rho = 1 \qquad 2\,l/a = 2$ sec.

second. (Effective gate area is 2.5 times the original). Let the movement of the gate take place in three intervals of 3 seconds each, so that $3\left(\frac{2l}{a}\right) = 9$ seconds. The data give $\rho = 3$.

The diagram for this case is shown in Fig. 8. The initial parabola is drawn for $E = .4$ and a series of parabolas are drawn for E = .5, .6, .7, .8, .9, 1.0, from which pressures and velocities at both the middle and the ends of the intervals are easily found. The slopes of all the lines have tangents + 6 or − 6 and the construction needs but brief explanation. For the first interval the pressure and velocity may be scaled off, at the middle and end of it, from points A 1.5 and A 3, whereas A 4.5 and A 6 give the corresponding values for the second interval, and A 7.5 and A 9 for the third, the pressure falling to $A\,9 = .55\,H_0$ at the instant gate movement stops, and the velocity at this instant is $0.75 \times 5 = 3.75$ feet per second. If the gate

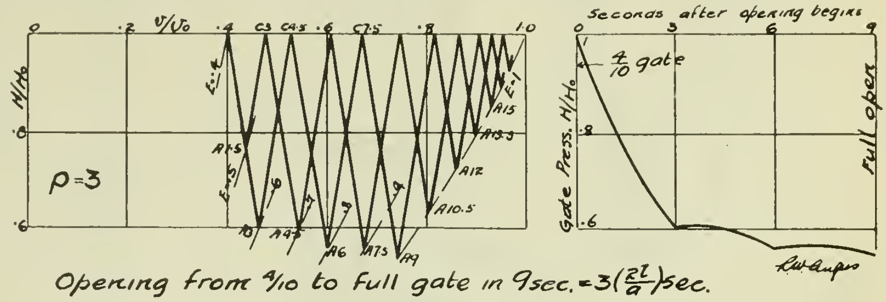

Fig. 8—Gate Opening from Part to Full Gate.
$\rho = 3 \qquad 2\,l/a = 3$ sec.

remains in this fixed position then the lines following A 9 give the pressure and velocity changes until the final steady position $v/v_0 = 1$ and $H/H_0 = 1$ is reached. The pressure diagram for 9 seconds only, is given at the right of Fig. 8.

A rather interesting example is shown in Fig. 9, which corresponds to the case where a valve, originally closed, is opened in one interval of $2\,l/a = 3$ seconds, and then closed again in the same time. In this case, one starts at the point $v = 0$ and $H = H_0$ and the first opening movement is represented by a line A_0A_3 with slope of tangent $-\,2\,\rho$, this line terminating on the parabola $E = 1$. This line is followed by another sloping at $+\,2\,\rho$ and terminating on the line $H = H_0$ at $C = 4.5$, representing equation (19), which gives the condition at the reservoir at the end of 4.5 seconds. By drawing the line C 4.5 A 6, the pressure at final closure is obtained on the line $v = 0$. If it is desired to get the oscillation of pressure following closure, the construction is continued about the vertical through $v = 0$.

The figure shows two cases, each with $2\,l/a = 3$, the left hand diagram employing a large value of $\rho = 1.9$ and the right hand one a much smaller value of $\rho = 0.25$. The parabola $E = .5$ enables the pressures and velocities at the middle of each interval to be drawn. For the large value of ρ (low head) the peculiar case results of the pressure after closure exceeding that at the time of closure.

Resonance

It may happen that if a governor lacks stability it will swing the gates to and fro, "hunting" for a position where the gate should finally remain. If the governor causes each inward swing and each outward swing to take place in $2\,l/a$ seconds, then a condition of resonance is set up, and in an unfavourable case very high pressures may result. This problem is very easily examined by the graphical construction already described.

Suppose that a plant has a riveted steel penstock 1,765 feet long, with a velocity of 4 feet per second, at full gate under a head of 73 feet. Let a = 3,530 feet per second.

then $\rho = \frac{3530 \times 4}{64.32 \times 73} = 3$ and $2\,l/a = \frac{1765 \times 2}{3530} = 1$ second.

Now suppose the governor is so adjusted as to completely close the gates in 3 seconds, or three intervals for the pipe, and let this plant be running at full load, followed by a sudden rejection of part load which is sufficient to start the

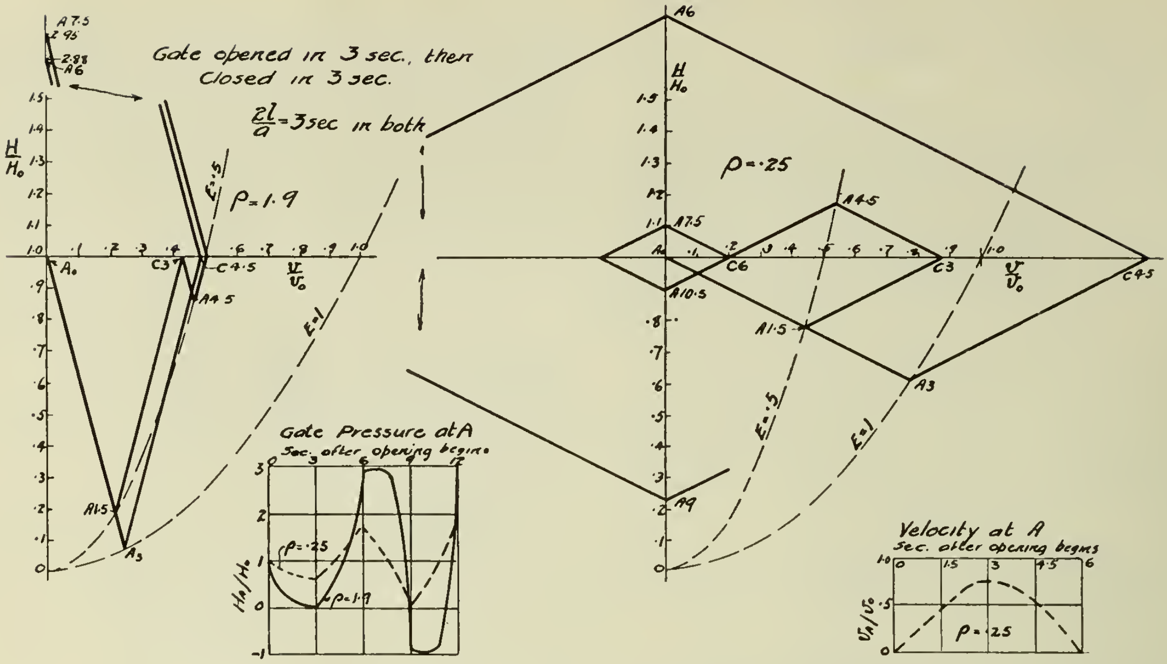

Fig. 9—Gate Opening Followed by Closure, each requiring $2\,l/a$ sec.

governor, and with it the gates, to swing repeatedly between full gate and 2/3 gate, the time of movement in each case being one interval of one second. The diagram for this case is shown on the upper part of Fig. 10, and evidently the

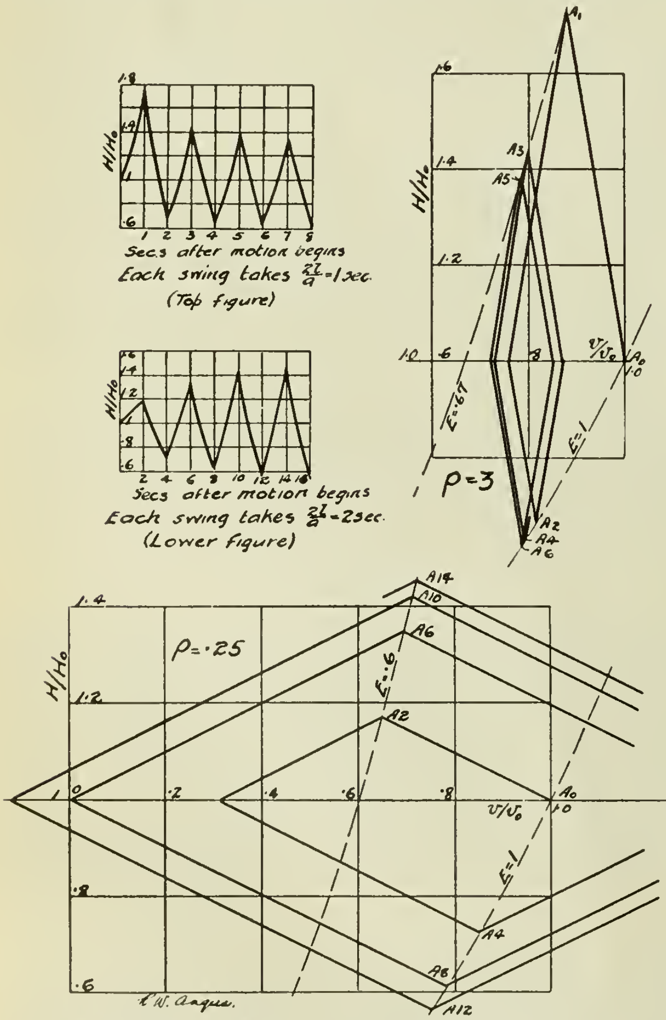

Fig. 10—Resonance Effect due to Continual Swinging of Gate between part and full opening, each Swing taking $2\,l/a$ sec.

two parabolas $E = 1$ and $E = 0.67$ will give the limiting positions of the pressure lines.

Since the first movement is from full open gate, the first pressure line starts at A_0 (upper diagram in Fig. 10) and slopes upward so that its tangent is $-2\rho = -6$ and the pressure at the end of the first closing movement is $H/H_0 = 1.734$, the velocity being $0.88\,v_0 = 3.52$ feet per second. The construction shows that at the first opening movement following, the pressure falls to $0.66\,H_0$ and at the ends of the successive movements the pressures are 1.44, 0.62, 1.39, 0.616 times H_0, or the pressure surge is gradually dying out, as is clearly indicated on the pressure diagram shown (top figure).

If, however, this same governor is used on a pipe of exactly similar dimensions but with an initial head of $12 \times 73 = 876$ feet, then $\rho = 0.25$ and the result is shown on the lower diagram of Fig. 10, which indicates that the pressure surge is continually increasing and must in time become very dangerous, although for the swings illustrated it has not reached the value shown in the upper case in the first movement. Whether the resonance effect is dangerous or not, clearly depends largely on the value of ρ, all other conditions remaining unchanged.

Simple Surge Tank

A further illustration of the use of this method is given in the simple surge tank. The case solved in Fig. 11 is that of a plant with 3,400 feet of 48-inch pipe with a surge tank 12 feet diameter, and a full-load pipe velocity of 9 feet per second. The static head on the plant is 200 feet, and it is desired to plot the surge tank levels resulting from a sudden reduction of load to 1,000 h.p. These levels are determined if the pressures at A, the surge tank end of the conduit are known; C is at the reservoir end. The value of a will be taken as 3,400 feet per second, so that $2\,l/a = 2$ seconds, and friction will be considered in this case.

Equation (8) is suitable for this problem and is best written

$$\frac{H_n + H_{n-1}}{2} - H_0 = +\frac{a}{g}\left(\frac{v_{n-1} - v_n}{2}\right) \ldots\ldots (8)$$

where H_n and H_{n-1} are the heads at the nth and the $(n-1)$th intervals, respectively. The axes for plotting are the velocity v in the conduit and the rise in tank level, which also gives, on the same axis, the head H. By any of the ordinary methods the hydraulic gradient may be drawn, which shows the level in the tank corresponding to each steady velocity in the 48-inch pipe, and it is quite easy also to plot a curve of demand velocity u in this pipe for 1,000 h.p. at each head, suitable assumptions being made as to the turbine efficiency. These two curves are shown in the figure.

In this case the pressure lines are evidently to be drawn so that their tangents are $\pm \frac{a}{g} = \pm 105.7$. The construction throughout is the same, but that at the 19th interval has been selected for illustration.

Equation (8) for this interval is

$$\frac{H_{A38} + H_{A36}}{2} - H_{0.38} = + \frac{a}{g}\left(\frac{v_{36} - v_{38}}{2}\right)$$

The point A 36 represents v_{36} and scales 7.223 feet per second, also the surge tank level at the end of 36 seconds, or of the 18th interval, is at A 36, and by scale from the drawing $H_{A36} = 194.88$ feet. The H_0 for this interval corresponds to the value of C 37 and is 187.09 feet.

But in addition to equation (8) there is another equation which may be written

$$A_P\,(v - u)\ \delta t = A_T \times \text{rise in tank in time } \delta t \text{ second}$$

where A_P and A_T are, respectively, the areas of the pipe and tank. Since $\delta t = 2\ l/a = 2$ seconds, the rise in the tank level in one interval is evidently $H_n - H_{n-1}$ so that

$$A_P\,(v - u)\ \delta t = A_T\,(H_n - H_{n-1})$$

or, since the surge tank area is 9 times that of the pipe

$$v - u = \frac{9}{2}\,(H_n - H_{n-1})$$

The drawing shows how $H_n - H_{n-1}$ may be read off directly on a specially made cardboard scale, where 9 inches on the special scale corresponds to 2 inches on the velocity scale. Scaling from the diagram

$$(v_{36} - u_{36}) \times \frac{2}{9} = 0.60 \text{ feet}$$

so that

$$H_{38} - H_{36} = 0.60 \text{ feet}$$

and by drawing the line C 37-A 38 at a slope with a tangent $- a/g = -105.7$ and locating A 38 at 0.60 foot above A 36 gives the level at A 38 at the 19th interval, or $19\left(\frac{2l}{a}\right) = 38$ seconds after the load rejection. Drawing the line A 38-C 39 with slope $+ 105.7$ locates point C 39 at the end of the 19th interval, and the velocities at the end of

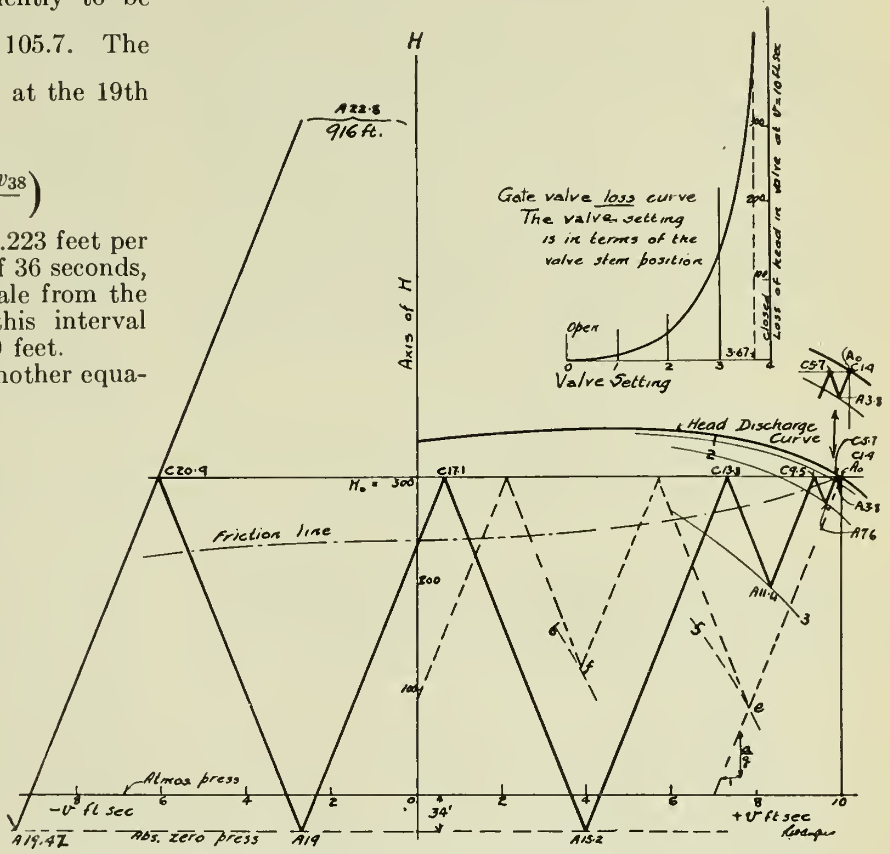

Fig. 12—Discharge Valve Closed with Pump Running up to Speed.
$a = 3{,}220$ ft. sec. $\quad 2\,l/a = 3.8$ sec.

the 18th and 19th intervals are found by scaling the positions of A 36 and A 38, respectively, from which $v_{36} = 7.223$ feet per second and $v_{38} = 7.07$ feet per second. These

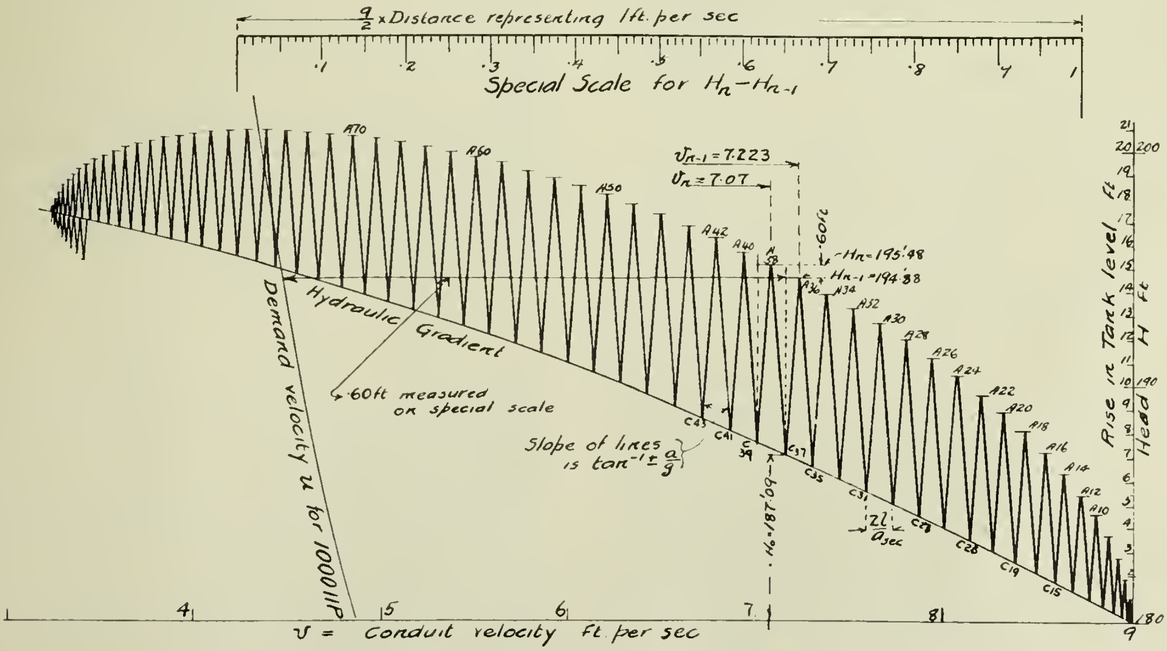

Fig. 11—Simple Surge Tank 12 ft. dia. at the end of 3,400 ft. of 48 in. pipe.
$H_0 = 200$ feet. $\quad v_0 = 9$ ft. sec. $\quad a = 3{,}400$ ft. sec.

results are easily checked by the use of equation (8) which gives

$$\frac{195.48 + 194.88}{2} - 187.09 = 8.09 \text{ feet}$$

and also

$$-\frac{a}{g}(v_{38} - v_{36}) = -105.7\left(\frac{7.07 - 7.223}{2}\right) = 8.09 \text{ feet},$$

as before.

By carrying on this process throughout it is easy to find the change of level and the change of velocity in each interval of $2\,l/a = 2$ seconds, and from these to plot a curve of the tank level and the pipe velocity variation. The whole process is executed very simply by the graphical process exclusively. The process could be used with the differential tank and probably with much less chance of error than by the arithmetic integration method.

This solution is the same as that already used although slightly different in appearance. Equations (13) and (16), when applied to this case in which $2\,l/a = 2$ seconds give:—

$$H_{A\,36} - H_{C\,35} = -\frac{a}{g}(v_{A\,36} - v_{C\,35}) \quad \text{(16)}$$

$$H_{C\,37} - H_{A\,36} = +\frac{a}{g}(v_{C\,37} - v_{A\,36}) \quad \text{(13)}$$

$$H_{A\,38} - H_{C\,37} = -\frac{a}{g}(v_{A\,38} - v_{C\,37}) \quad \text{(16)}$$

The difference in the heights of $H_{A\,36}$ and $H_{A\,38}$ is found as in the other case. The diagram is too cramped to show all the points, but a few of them have been marked according to the notation of the above equations.

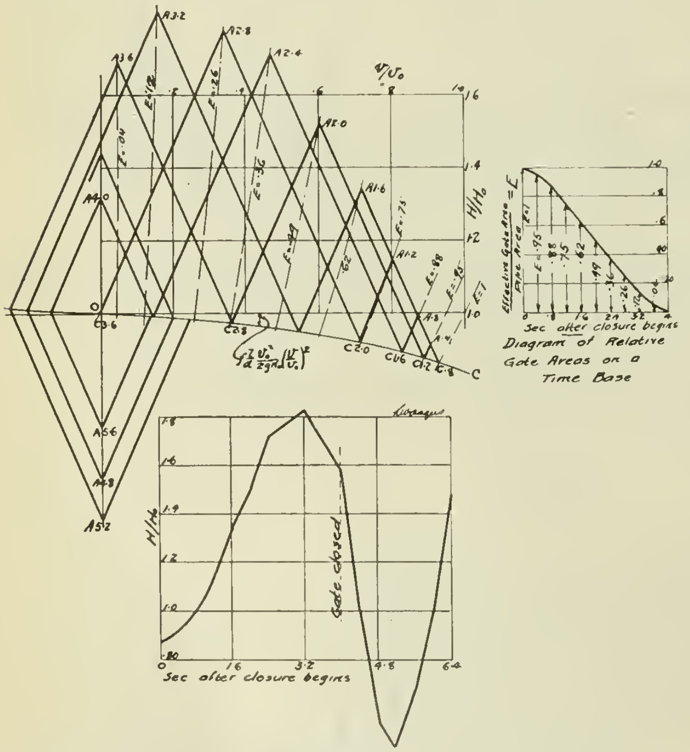

Fig. 13—Gate Closure according to Curve Shown in 4 sec.
$2\,l/a = 1.6$ sec. $\rho = 1.125$ Pipe Friction allowed for (see Fig. 6).

Pump Discharge Lines

Of recent years the very common practice of driving centrifugal pumps with electric motors has produced a water hammer problem of no small importance, because, through failure of power supply or other cause, the current to the motor may be suddenly cut off, and unless special precautions are taken, the stopping of the return flow of the water may produce disastrous results. Pump discharge lines are always provided with a gate or check valve near the pump, and unless it is properly adjusted and operated the pressure rise may be very great; for example, if the check valve is mechanically closed and held in that position immediately after the power fails, then the outward flow of the water will continue for a brief interval, causing a vacuum on the pipe side of the valve, and when the return column again reaches the closed valve the pressure may rise to about four times the normal value.

The magnitude of this water hammer depends not only on the type of check valve used but also on the construction of the pump itself; if the rotating elements in the motor and pump have a small moment of inertia the pump may stop almost instantly and, indeed, it may actually reverse, running as a turbine, before the check valve stops the return flow. In this paper it is not possible to do more than suggest the method of solution of some problems that arise in this connection.

The first case examined will be the determination of the pressure changes produced in a pipe line by closing the pump discharge valve, while the pump is still running up to speed. To take a definite case, let a pump with a known characteristic curve be discharging into a pipe line 6,120 feet long with a value of $a = 3{,}220$ feet per second, and let the gate valve on the discharge side of the pump be closed in 15.2 seconds in such a way as to lower the disc in the valve at a uniform rate. Evidently for the pipe, $2\,l/a = 3.8$ seconds, so that complete closure is effected in four intervals. Experiments on the loss of head in the valve in terms of the pipe velocity give the loss curve shown at the right of Fig. 12, the base line of which represents the position of the valve disc, and, from the assumption as to closing, represents also times in seconds, or in intervals of $2\,l/a$. On Fig. 12 the characteristic head discharge curve of the pump is drawn, and beneath this is a series of curves showing the pressures on the pipe side of the valve corresponding to each gate position, or more conveniently to each interval of 3.8 seconds during closing. The numbers on these curves correspond to those on the resistance diagram on the right, and data for them are taken from the resistance curve.

For this case equations (13) and (16) may be written in the form

$$H_{Ct} - H_{At\,1} = +\frac{a}{g}(v_{Ct} - v_{At\,1})$$

$$H_{At} - H_{Ct\,1} = -\frac{a}{g}(v_{At} - v_{Ct\,1})$$

Friction in the pipe line will be neglected, so that the pressure at the pump end corresponding to the reservoir level is 300 feet, and further, since $2\,l/a = 3.8$ seconds the value of $t - t_1 = 1.9$ seconds. For the first few points

$$H_{A\,3.8} - H_{C\,1.9} = -\frac{a}{g}(v_{A\,3.8} - v_{C\,1.9})$$

$$H_{C\,5.7} - H_{A\,3.8} = +\frac{a}{g}(v_{C\,5.7} - v_{A\,3.8})$$

$$H_{A\,7.6} - H_{C\,5.7} = -\frac{a}{g}(v_{A\,7.6} - v_{C\,5.7})$$

The points A 3.8, A 7.6, A 11.4, C 1.9, C 5.7, C 9.5, are shown on the figure, and the explanation given for former cases suffices for this one.

The diagram shows quite clearly that this method of operating the valve is very bad, because the line C 13.3-A 15.2 should end on the line $v = 0$ for the closed valve. It is, however, unable to do so, because a perfect vacuum exists at A 15.2, and yet there is a velocity of 3.86 feet per second toward the reservoir, so that an empty space will form on the reservoir side of the valve and the pressure will remain at absolute zero during the whole of this 3.8-second interval, since the changes of pressure are assumed instantaneous at the beginning of each interval. At the end of the interval the flow of water will reverse in direction, and when the whole column strikes the valve the flow will be suddenly stopped because the valve is closed.

At the next (fifth) interval the pressure and velocity are represented at A 19 where the velocity toward the pump is 2.82 feet per second, but at this point the empty space behind the valve has not been filled because its original volume was

$$3.86\left(\frac{2\,l}{a}\right) A_P = 3.86 \times 3.8\, A_P = 14.7\, A_P \text{ cubic feet,}$$

where A_P is the pipe area in square feet, and the volume put back into it in this interval is only

$$2.82 \times 3.8\, A_P = 10.7\, A_P \text{ cubic feet.}$$

In the next interval the pressure and velocity correspond to A 19.42 which shows a negative velocity (toward the gate) of 9.50 feet per second. The space will then be completely filled in $\frac{(14.7 - 10.7)\, A_P}{9.5\, A_P} = 0.42$ second after point A 19 is reached.

Since at the instant the water is stopped it has a velocity of 9.50 feet per second, the pressure rise will be $9.50\left(\frac{a}{g}\right) = 950$ feet above absolute zero, or a gauge pressure rise to $950 - 34 = 916$ feet, as shown in Fig. 12. The pressure due to water hammer in this case is thus 3.05 times the normal operating pressure, and in the next interval the pressure reaches its maximum of 1.584 feet.

In this case friction has been neglected, but may easily be taken into account. Suppose the loss in the line at full draught is 60 feet then the friction line corresponding to this loss is drawn, with a dot and dash curve, below the horizontal line through the normal operating point A_0 where $H_0 = 300$ feet. This friction line may then be used as the locus of all points C, since the effect of friction is practically to lower the reservoir, as the velocity decreases. The construction for this case is easily drawn, but has been omitted to avoid confusion of the figure, but it will, of course, show a lower pressure rise.

A much better method of operation would be to close the valve in the first interval of 3.8 seconds, to correspond to the curve 5, this being the resistance curve corresponding to $3.67/4 = 92$ per cent of complete closure. The pressure will then fall to e and if in the next interval the gate reaches the position where the loss through it corresponds to curve 6 the pressure will fall to f, and closure may be completed in the next interval with a final fall in pressure to g of 92 feet, or a drop of 208 feet below normal pressure. In this case the pressure will oscillate 208 feet above and below normal pressure till the wave dies out through friction. This case is also shown in dotted lines in Fig. 12, no allowance being made for friction in the pipe line.

Effect of Friction

While it is not difficult to include friction, it has been neglected in this paper in most cases except that of the surge tank; the example there, however, shows how it may be allowed for. Care must be taken to make a proper distinction between flows to and from the reservoir, because friction acts in opposite ways in the two cases. Only one further illustration will be given on this point.

If it were desired to solve the same problem as in Fig. 6, but considering friction in the pipe line, the solution would be modified. Friction in the line produces, in this case, an effect similar to the gradual raising of the reservoir level as the flow decreases, and hence the former construction may be used, if instead of using a horizontal line to represent reservoir levels, a curved line is used, such that its distance below the horizontal, at any velocity, represents the loss of head at that velocity.

The case shown in Fig. 13 uses the same data as on Fig. 6, but friction has been considered and also the rate of gate closure, instead of being uniform, is variable, as shown on the right hand diagram of Fig. 13. The friction line OC represents the substituted changing reservoir level, the vertical distance to the horizontal line at any point representing, for the corresponding velocity, the loss of head divided by H_0. This distance may be calculated by the formula

$$f \cdot \frac{l}{d} \cdot \frac{v^2}{2g} \cdot \frac{1}{H_0} = f \cdot \frac{l}{d} \cdot \frac{v_0^2}{2\,gH_0} \cdot \left(\frac{v}{v_0}\right)^2$$

where f is the friction factor and d the pipe diameter. If this curved base is used instead of the horizontal one, the resulting pressures will be those that would result if friction is considered. The complete solution is shown and should need no explanation.

Conclusion

While the problems solved here as illustrations have not, so far as the author knows, appeared elsewhere, at least not in English, yet the theory used has been developed in Europe and has been briefly mentioned in the recent Water Hammer Symposium of the American Society of Mechanical Engineers.

It is a pleasure to acknowledge the help received from the excellent papers of Dr. O. Schnyder(6) of Switzerland, particularly that entitled "Uber Druckstösse in Rohrleitungen," appearing in Wasserkraft und Wasserwirtschaft in March 1932. Dr. Schnyder has devised some elegant solutions to such problems as those under consideration. A valuable paper by Professor L. Bergeron(7) on "Variations de régime dans les conduites d'eau" appeared in the Proceedings of the Société Hydrotechnique de France 1932. The author is also greatly indebted to the paper by A. W. K. Billings(8) and others on "High Head Penstock Design," presented to American Society of Mechanical Engineers last year; the application of the method explained here to a pipe of varying diameter is given in that paper. Reference may also be made to the work of Dr. L. Loewy.(9)

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(9) Druckschwankungen in Druckrohrleitungen. By Dr. L. Loewy. Published by Springer, Berlin, 1928.

Report of Council for the Year 1934

Last year the report of Council drew attention to the improvement in business activity which had become manifest towards the end of the year. During the twelve months which have elapsed since then the anticipated progress has continued, although not so vigorously as could be wished. Industrial statistics now available continue to show an upward trend, and it is encouraging to note that the number of members of The Institute known to be unemployed has been reduced since this time last year.

During the year a considerable number of members have found it necessary to ask to be carried on the non-active list, and the decrease in the number of members on the roll of The Institute is largely due to this cause. There is, however, encouragement in the fact that the number of applications for admission shows a substantial increase over 1933, and that applications are beginning to come in from members who are on the non-active list, and who desire to resume their active connection with The Institute.

From the Finance Committee's report it will be noted that the income and expenditure for 1934 have agreed closely with the budget. The Council realizes that this desirable result is largely due to the careful control of expenditure exercised by the Finance Committee and to the painstaking and thorough study of our financial condition made at the beginning of the year.

The Council also desires to express appreciation of the way in which the members of The Institute have responded to requests to reduce the arrears of outstanding dues. It must be realized that as long as any considerable number of members remain on the non-active list, services to members may have to be curtailed, while any increase in such service will be impossible.

In order to lighten the initial cost of joining The Institute during these difficult times, your Council has deemed it advisable to keep in force, for the coming year, the reduction of the entrance fee to $5.00 for all classes of membership. This was put into effect last year and the Annual Meeting will be asked to approve Council's action.

The number of our members engaged in the work of the Relief Camps of the Department of National Defence is now decreasing, and as there have been many cases in which our members were aided and relieved by the Department's action in making employment in these camps available to them, it is fitting that the Council should here record the indebtedness of The Institute to the Department and to Major-General A. G. L. McNaughton, C.B., M.E.I.C., for all that has been accomplished in furnishing relief by acceptable employment to so many members in their time of need.

During the past year the officers of The Institute have spoken and corresponded with Ministers of the Crown regarding the difficulties which are now being experienced by young engineering graduates in finding work of a kind that will give them professional experience. Although the Ministers gave no promises their replies were sympathetic.

In this connection Council has noted with regret the many cases in which recent graduates have not been able to secure employment which will allow them to apply instead of lose their university training. Council would draw attention to the increasing number of positions in connection with the works of our manufacturing or fabricating industries in which technically trained graduates, who have acquired the necessary practical experience in construction or workshop methods, can now find openings. These give opportunities different, perhaps, from those arising in the older paths of engineering employment, but which nevertheless enable the young engineers to utilize their professional training to great advantage.

An encouraging feature of recent Institute activities has been the effective work done by the Junior Sections of several of our branches. These have organized and held many well attended section meetings, at which worth-while papers have been presented and discussed by Juniors and Students of The Institute. The Peterborough and Montreal Branches have been particularly successful in this respect, and the Council feels that their efforts may with advantage be emulated by an increasing number of other branches.

The proposed new by-laws drafted last year, and adopted at the Sixth Plenary Meeting of Council in October 1933, were duly discussed at the Annual Meeting of 1934 before being sent out to ballot. The proposals failed to carry, for although the affirmative votes numbered 505 and the adverse votes 289, 24 affirmative votes were lacking to reach the necessary two-thirds majority. The suggestion has been made that, without re-opening the whole question, it may be advisable to put forward again those of the proposals whose adoption would tend to improve the routine and administrative conduct of affairs of The Institute, leaving controversial matters until more unanimity is evidenced.

Your Council has not been advised that any further progress has been made by the Associations' Committee of Eight in regard to the co-ordination of the activities of the eight Associations of Professional Engineers. In the meantime an effort has been made in Manitoba towards co-operation between the Winnipeg Branch of The Institute (whose territory includes the whole of Manitoba) and the Association of Professional Engineers of Manitoba. As a result the Winnipeg Branch requested the Council to approve certain changes in the branch by-laws and organization, which would be required to enable that branch of The Engineering Institute and the local Professional Association to function under a common executive and staff. This project, which was frankly experimental, received the Council's hearty approval as a trial measure, and was endorsed by the membership of the Winnipeg Branch of The Institute, but since a ballot of the Professional Association membership showed only a small majority in favour of this action, the Council of the Association felt it would be unwise to recommend its adoption at present.

Your Council has supported as far as possible the activities of the National Construction Council of Canada in its efforts to promote the revival of the construction industry.

At the request of a special Committee on National Sound Finance appointed by the Canadian Chamber of Commerce, a committee appointed by Council under the chairmanship of Mr. R. E. C. Chadwick, M.E.I.C., has submitted a report recommending the procedure desirable in calling for tenders and letting contracts for public works. This has been forwarded to the National Committee.

Your Council has given its support to the nomination of engineers on the Directorate of the Bank of Canada with the object of having the profession represented on the Board.

The second issue of the E-I-C Engineering Catalogue has been commented on favourably. Letters received indicate that the volume has been found of use by an increasing number of members and non-members. The third issue, for 1935, now in the press, embodies a number of improvements and the corrections necessary to bring its index up to date. The financial results for the first two years have been disappointing, but it is expected that this next issue will not entail any loss.

From time to time members who have given papers at their branch meetings have been good enough to visit other branches and repeat their addresses or demonstrations, often at considerable personal sacrifice of time and energy. Your Council desires to acknowledge with many thanks public-spirited effort of this kind, which does so much to bring together the widespread membership of The Institute, and is particularly appreciated by the smaller branches.

Your Council has noted with appreciation the active interest shown in the affairs of The Institute, on the occasion of the President's visits to the various branches throughout Canada. On these occasions many important matters concerning the future of The Institute were brought to the attention of the branch members, in the hope that they will give serious thought to such topics, and that The Institute will thus have the benefit of their deliberations when future opportunities for progress arise.

The Forty-Eighth Annual General and General Professional Meeting was held in Montreal on February 8th and 9th, 1934, the formal Annual General Meeting of January 25th having been adjourned to those dates. Although the meeting was limited to two days for reasons of economy, its unqualified success showed the result of the excellent preliminary work of the committee of the Montreal Branch who sponsored it.

The greater part of the business session was taken up by a discussion of Council's proposals for amendments to the by-laws, prior to their submission to the membership for ballot. The debate was active, and a large number of members took the opportunity of offering suggestions and criticisms, particularly with regard to the possible effect of the proposed amendments upon the future relations of The Institute with the Provincial Associations.

The social functions were well attended, and at the Annual Dinner of The Institute, the Prime Minister, The Rt. Hon. R. B. Bennett, was kind enough to present the prizes and medals, and delivered an inspiring address with a message of hope particularly addressed to the younger members of the profession. At the technical sessions nine papers were presented and discussed, and the meeting concluded with an enjoyable smoker at which a novel feature was a boxing tournament.

The Western Professional Meeting, which took place in Vancouver on July 11th to 13th, was memorable as it was held in conjunction with the Annual Convention of the American Society of Civil Engineers. Arrangements for this joint event were in the hands of an active local committee composed of members of both societies, under the chairmanship of Mr. E. A. Cleveland, M.E.I.C., to whom the thanks of Council and The Institute are due for the able way in which the meetings were organized and the success which attended their work. The social features of the meeting were held jointly by the two societies; the technical sessions were held separately. Both organizations were well represented and at the meetings of the American Society of Civil Engineers no less than twelve papers were presented and discussed. Our own list, while less numerous, included a series of papers dealing with western engineering work. In arranging for the social features and excursions, the committee, as was to be expected, took full advantage of the amenities of the City and its beautiful surroundings. These favourable conditions, combined with the traditional western hospitality, made the gathering one which will be long remembered. It was the first occasion on which an Institute meeting has been held jointly with a convention of a sister society, and the result was all that could be desired. All our members were happy to take part in welcoming their fellow engineers from the United States.

Roll of The Institute

During the year 1934, one hundred and seventy candidates were elected to various grades in The Institute. These were classified as follows:—Ten Members, forty-one Associate Members, twelve Juniors, one hundred and one Students, and six Affiliates. The elections during the year 1933 totalled one hundred and twenty-eight candidates.

Transfers from one grade to another were as follows:—Associate Member to Member, seven; Junior to Associate Member, thirty-eight; Student to Associate Member, nineteen; Student to Junior, twenty-nine; Junior to Affiliate, three; Affiliate to Associate Member, one; a total of ninety-seven.

The names of those elected or transferred are published in The Journal each month immediately following the election.

Removals from the Roll

There have been removed from the roll during the year 1934, for non-payment of dues and by resignation, ten Members, thirty-one Associate Members, eight Juniors, one hundred and fifty Students, and eleven Affiliates, a total of two hundred and ten.

Two hundred and three reinstatements were effected and eleven Life Memberships were granted.

During 1934 four hundred and thirty-nine names were placed on the Non-active List which now numbers six hundred and nine.

Deceased Members

During the year 1934 the deaths of thirty-eight members of The Institute have been reported as follows:—

Honorary Member

Aberdeen, The Right Hon. The Earl of, P.C., K.T., G.C.M.G., G.C.V.O.

Members

Armstrong, Major-General Charles Johnstone, C.B., C.M.G., V.D.
Aylmer, John Athalmer
Bowman, Archibald Abercromby
Chadwick, Kenneth Murray
Cruttwell, George Edward Wilson
Donkin, Hiram Fergusson
Fuller, George Warren
Gauvreau, Narcisse Belleau
Gore, William
Green, Samuel Martin
Helbronner, Pierce Michel
Hoare, Edward Arthur
Johnson, George Arthur
Lee, William States
Milne, James
Seurot, Paul Albert Nicolas
Svenningson, Sven
Wardwell, William Henry
Wynne-Roberts, Lewis Wynne

Associate Members

Archibald, Cyrus Witter
Ashley, Bertram Scott
Aylmer, Harry Brooke
Bernier, Jos. Adelard
Code, Abram Silas
Cunningham, William John
Fox, Charles James
Milne, Alexander
Munro, John Herbert
Murphy, Michael Joseph
Panneton, Frank
Philipps, James Benjamin
Pope, Harry Bonfield
Rounthwaite, Cyril Henry Ernest
Shector, Sidney Samuel
Treanor, Walter Charles
Vanier, J. Emile

Student

McBeath, Ernest Harrison

The membership of The Institute as at January 1st, 1934, totals three thousand, seven hundred and sixty-four, The corresponding number for 1933 was, four thousand. and seventy. These figures do not include those members who have been placed on the Non-Active List.

Total Membership

	1933		1934
Honorary Members	9	Honorary Members	8
Members	965	Members	914
Associate Members	1,894	Associate Members	1,782
Juniors	346	Juniors	299
Students	820	Students	727
Affiliates	36	Affiliates	34
	4,070		3,764
Members on Non-Active list	337	Members on Non-Active list	609
	4,407		4,373

Respectfully submitted on behalf of the Council,

F. P. Shearwood, M.E.I.C., *President.*
R. J. Durley, M.E.I.C., *Secretary.*

Finance Committee

The President and Council:—

The Finance committee, in submitting the auditors' and their own report, do so with a definite feeling of encouragement in view of the fact that, in spite of continued and seemingly unabated depression in active construction and general engineering work, the figures show a tendency toward recovery.

With the experience of 1933 to guide them, your committee balanced the budget in January on a basis of about $56,500.00 revenue and expenditure, including the third catalogue, which it was then hoped would yield a profit of about $1,250.00. On a strictly cash basis this meant that apart from the catalogue an operating deficit of $1,250.00 was considered permissible. Actually, apart from the catalogue, the year's balance sheet shows a surplus of $621.77 which has permitted the reinsertion of depreciation on the furniture and books, in the auditors' statement, as a charge against operations. This item was deliberately omitted last year in view of the abnormal deficit encountered. The depreciation is set up as $670.68 with the result that a small deficit of $48.91 is indicated in the auditors' report.

The income from all sources exceeded the budget by over $2,500.00 and, as the revenue from Journal advertising was guessed within 1/20th of 1 per cent, the improvement is due almost entirely to the enjoyment of a better response from the paying membership than your committee, in their 1933-born pessimistic mood, dared to anticipate, and this applies to current fees, entrance fees, and arrears of fees. As a matter of fact, at the end of 1931 the latter item is lower in amount than ever before and the actual number of members in arrears is also the smallest on record. The expenditure on services was allowed to exceed the budgeted amount by $1,329.46 in accord with the policy of doing the best possible for the membership under present circumstances, but the authorized list of office salaries furnished by your committee to the General Secretary early in February was strictly adhered to. The actual increases were largely consumed in the two items of rebates to Branches, and Professional Meetings, the former of course automatically, and the latter by resolution.

The basis of operations is shown in the Auditors' statement to be about $45,500.00 income and expenditure (exclusive of the catalogue) which compares with an expenditure of $47,129.76 in 1933 and with figures running considerably over $80,000.00 in years like 1924, 1929, and 1930.

By agreement, the catalogue finances are omitted from the general statement of revenue and expenditure this year, so that the possibility of fogging the result by the inclusion of "estimated" items of considerable magnitude, is removed. It is even yet, at the date of writing, too early to make estimates for the third catalogue, just now going to press, with much precision, so that the pertinent figures are all deferred until the 1935 report when they will be known exactly.

Meanwhile, the net result of the first two editions can now be definitely appraised. The assets of The Institute have been drawn upon to finance the publication of these catalogues, against which can be listed the building up of a valuable good-will and a prospect of future revenue.

STATEMENT OF ASSETS AND LIABILITIES AS AT 31st DECEMBER, 1934

Assets

CURRENT:		
Cash on hand and in Savings Account		$ 113.70
Accounts receivable	$ 2,316.34	
Less: Reserve for bad debts	332.88	
		1,983.46
Arrears of fees—Estimated		2,500.00
Advance Travelling Expenses		25.00
		4,622.16
SPECIAL FUNDS—Per Statement attached:		
Investments	10,980.14	
Cash in Savings Bank	773.81	
Due by Current Funds	1,314.98	
		13,068.93
INVESTMENTS—At cost:		
$100 Dominion of Canada 4½%, 1946	96.50	
$200 Dominion of Canada 4½%, 1958	180.00	
$4,000 Dominion of Canada 4½%, 1959	4,090.71	
$500 Province of Saskatchewan 5%, 1959	502.50	
$1,000 Montreal Tramways 5%, 1941	950.30	
$2,000 Montreal Tramways 5%, 1955	2,199.00	
$500 Title Guarantee and Trust Corp. Certificate past due	500.00	
2 Shares Canada Permanent Mortgage Corp.	215.00	
40 Shares Montreal Light, Heat & Power Cons. N.P.V.	324.50	
		9,058.51
ADVANCES TO BRANCHES		175.00
DEPOSIT—Postmaster		100.00
PREPAID EXPENSES:		
Stationery	517.74	
Unexpired insurance	80.00	
		597.74
DEFERRED CHARGES:		
Expenses of 1934-35 Catalogue incurred to date		3,531.97
GOLD MEDAL		45.00
LIBRARY—At cost, less amounts written off		1,609.03
FURNITURE—At cost, less amounts written off		4,427.11
LAND AND BUILDINGS—At cost (Assessed Value $57,200)		89,041.64
		$126,277.09

Liabilities

CURRENT:			
Bank Overdraft—Secured			$ 10,307.97
Accounts Payable			1,284.40
Rebates due to Branches			567.77
Library Deposits			12.50
Amount due to Past Presidents' Fund			1,314.98
			13,487.62
SPECIAL FUNDS:			
Leonard Medal		$ 628.79	
Plummer Medal		619.78	
Fund in Aid of Members' families		2,122.46	
Past Presidents' and Prize Fund		5,433.99	
War Memorial Fund		4,263.91	
			13,068.93
SURPLUS:			
Balance as at 1st January, 1934		101,368.42	
Deduct:			
Excess of Expenditure over Revenue for year ending 31st December, 1934	$ 48.91		
Adjustment of estimated 1933 Catalogue expenses	1,118.65		
Adjustment of estimated 1933 Catalogue revenue	480.32		
		1,647.88	
			99,720.54
			$126,277.09

MONTREAL, 10TH JANUARY, 1935.

Audited and verified, subject to our report of this date.

RITCHIE, BROWN & CO.,
Chartered Accountants.

While it can be foreseen that the cost of production on the third edition will be comparatively less than on previous editions, and while the chances of making a definite profit are still considered good by those best able to judge, it is hardly to be expected that the whole loss up-to-date can be recovered during 1935.

The advertising in The Journal has been remarkably steady month by month during the past year and this fact encourages the management and your committee to feel that the low point has not only been reached but passed, as the total income from this source is about $1,000.00 better than last year, although still only about 45 per cent of the average during the period 1925 to 1931.

In the statement of assets and liabilities it will be noticed that the surplus is again reduced, due to the loss on the second issue of the catalogue having been greater than estimated in the 1933 report. The value of the land and buildings at Headquarters is noted as an "at cost" figure which is undoubtedly seriously in excess of present day valuation. No capital increase to the library or furniture has been made during the year and the Branches have returned some $225.00 of advances. Investments remain unaltered but the temporary bank overdraft is slightly higher than previously. Members will doubtless realize that while the expenditures are reasonably uniform month by month, the majority of the income of The Institute both from fees and from the catalogue, reaches Headquarters in the first three months of the year and is sufficient to wipe out the above overdraft entirely by March or April, but that toward the end of the year the overdraft will inevitably build up again until such time as a greater cash surplus has been established.

Your committee has been constantly faced with the difficult problem of recommending to Council some reasonable method of accommodating an increasingly large num-

(*Continued on page 86*)

COMPARATIVE STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEARS ENDING 31st DECEMBER, 1933 AND 1934

Revenue

	1933	1934
Membership Fees:		
Arrears	$ 1,658.86	$ 2,763.81
Current	22,766.43	22,302.02
Advance	309.44	412.45
Entrance	807.00	803.00
	$25,541.73	$26,281.28
Publications:		
Journal subscriptions and sales	$ 6,411.65	$ 6,165.28
Journal advertising	10,863.65	11,806.42
E-I-C- News advertising	30.50	....
**Catalogue* advertising—Estimated	12,176.87	....
	$29,482.67	$17,971.70
Income from Investments	$ 548.77	$ 514.79
Refund of Expenses of Hall	667.50	695.00
Sundry Revenue	79.45	77.78
*Total Revenue	$56,320.12	$45,540.55
Excess of Expenditure over Revenue for Year	3,732.73	48.91
	$60,052.85	$45,589.46

Expenditure

	1933	1934
Building Expenses:		
Taxes—Property and Water	$ 2,078.04	$ 1,950.99
Fuel	484.15	450.26
Insurance	124.00	104.87
Light	278.62	256.36
Caretaker's wages and service	907.50	758.00
Repairs and expenses	1,079.65	602.69
	$ 4,951.96	$ 4,123.17
Publications:		
Journal—Salaries	$ 4,872.46	$ 5,593.56
Expenses	11,677.33	10,889.86
E-I-C News Expense	112.97	....
†*Catalogue*—Salaries	4,345.20	....
Expenses—Estimated	8,577.89	....
Sundry printing	215.45	382.03
	$29,801.30	$16,865.45
Office Expenses:		
Salaries—Secretary and staff	$10,782.85	$10,583.44
Postage and telegrams	1,252.56	1,143.52
Office supplies and stationery	981.08	986.36
Legal and audit fees	275.00	250.00
Telephone	321.60	338.06
Messenger and express	87.31	97.61
Miscellaneous	224.54	73.32
Depreciation—Furniture—10%	....	491.90
	$13,924.94	$13,964.21
General Expenses:		
Annual and Professional Meetings	$ 1,915.85	$ 2,350.17
Plenary Meeting of Council—Less Branch contributions	1,127.21	....
Meetings of Council	210.31	129.34
Travelling—Secretary	122.16	185.48
Branch stationery	185.24	161.05
Students' Prizes	33.76	89.79
E-I-C Prizes	287.50	288.75
Gzowski Medal	....	17.25
Library—Salary	595.10	519.72
Expenses	774.10	443.86
Depreciation—10%	....	178.78
Interest, discount and exchange	124.71	406.73
Examinations—Cost less amount collected	75.00	86.91
Committee expenses	347.59	184.42
National Construction Council	150.00	80.00
	$ 5,948.53	$ 5,122.25
Rebates to Branches	$ 5,426.12	$ 5,514.38
Total Expenditure	$60,052.85	$45,589.46

*Total Revenue 1933		$56,320.12
Deduct: Catalogue advertising		12,176.87
Revenue 1933 comparable with 1934		$44,143.25

†Total Expenditure 1933		$60,052.85
Deduct: Catalogue—Salaries	$4,345.20	
Expenses	8,577.89	12,923.09
Expenditure 1933 comparable with 1934		$47,129.76

Finance Committee

(*Continued from page 85*)

ber of members who find themselves compelled to ask for extension of time in respect to the payment of dues, and a further large number who merely delay payment without advising The Institute at all as to their situation, prospects, hopes, or intentions.

The non-active list has been widely extended, but it is sincerely urged upon members that they regard this classification merely as a means of providing them some temporary relief from financial responsibility, but not as something to be endured or enjoyed longer than necessary. They are, therefore, respectfully asked to resume active membership at the earliest practicable moment and thus lend their co-operation to The Institute in its endeavour to serve the profession. There are many useful services to be resumed or extended when revenue permits; there are numerous lines along which The Institute can advantageously direct its energy and exert its influence when the funds available rise above the present level of barely meeting essentials. Gratified as your Finance committee feels with the degree of support advanced by the membership during 1934, particularly with the efforts made by certain Branches to encourage resumption of active membership and the early payment of fees, it is nevertheless felt that much more can and should be done toward increasing The Institute's potentiality for service.

Respectfully submitted,

P. L. Pratley, m.e.i.c., *Chairman.*

Nominating Committee—1935

Appointments to the Nominating Committee for the year 1935 have been made by the various Branches, and the Chairman has been appointed by Council, as shown on the following list, which is now presented for announcement at the Annual Meeting in accordance with the By-laws:—

Chairman: L. F. Grant, m.e.i.c.

Branch	*Representative*
Halifax Branch	A. F. Dyer, a.m.e.i.c.
Cape Breton Branch	R. R. Moffatt, a.m.e.i.c.
Saint John Branch	J. N. Flood, a.m.e.i.c.
Moncton Branch	C. S. G. Rogers, a.m.e.i.c.
Saguenay Branch	A. W. Whitaker, a.m.e.i.c.
Quebec Branch	P. Methe, a.m.e.i.c.
St. Maurice Valley Branch	J. H. Fregeau, a.m.e.i.c.
Montreal Branch	H. G. Thompson, a.m.e.i.c.
Ottawa Branch	J. McLeish, m.e.i.c.
Peterborough Branch	A. L. Killaly, a.m.e.i.c.
Kingston Branch	R. A. Low, a.m.e.i.c.
Toronto Branch	E. L. Cousins, m.e.i.c.
Hamilton Branch	J. R. Dunbar, a.m.e.i.c.
London Branch	H. A. McKay, a.m.e.i.c.
Niagara Peninsula Branch	C. G. Moon, a.m.e.i.c.
Border Cities Branch	S. E. McGorman, m.e.i.c.
Sault Ste. Marie Branch	A. H. Russell, a.m.e.i.c.
Lakehead Branch	
Winnipeg Branch	A. J. Taunton, a.m.e.i.c.
Saskatchewan Branch	P. C. Perry, a.m.e.i.c.
Lethbridge Branch	R. Livingstone, m.e.i.c.
Edmonton Branch	H. J. MacLeod, m.e.i.c.
Calgary Branch	H. W. Tooker, a.m.e.i.c.
Vancouver Branch	W. H. Powell, m.e.i.c.
Victoria Branch	J. N. Anderson, a.m.e.i.c.

Past-Presidents' Prize Committee

The subject announced for the year 1933-1934 was "The Engineering Features of City Management." No essays having been submitted, the committee is unable to make a report.

The hope is expressed that this condition will not be repeated in 1934-1935 since the subject prescribed, "The Co-ordination of the Activities of the Various Organizations in Canada," is of such importance and general interest.

SPECIAL FUNDS AS AT 31st DECEMBER, 1934

			Represented by:		
Leonard Medal Fund:					
Balance as at 1st January, 1934	$ 613.25		$500 Title Guarantee and Trust 6% 1933 Certificate	$ 500.00	
Add: Bond interest	30.00		Cash in Savings Bank	128.79	
Bank interest	2.79				
	646.04				
Deduct: Cost of Medals	17.25				
		$ 628.79			$ 628.79
Plummer Medal Fund:					
Balance as at 1st January, 1934	606.85		$500 Dominion of Canada 4½% 1959 Bonds	500.00	
Add: Bond interest	27.50		Cash in Savings Bank	119.78	
Bank interest	2.68				
	637.03				
Deduct: Cost of Medals	17.25				
		619.78			619.78
Fund in Aid of Members' Families:					
Balance as at 1st January, 1934	2,045.44		$1,000 Province of Ontario 4½% 1964 Bonds	1,022.17	
Add: Bond interest	100.00		$1,000 Dominion of Canada 4½% 1959 Bonds	972.97	
Bank interest	2.02		Cash in Savings Bank	127.32	
	2,147.46				
Deduct: Donation made to member	25.00				
		2,122.46			2,122.46
Past Presidents' and Prize Fund:					
Balance as at 1st January, 1934	5,308.53		$3,000 Montreal Tramways 5% 1955 Bonds	2,490.00	
Add: Contribution from Past President	100.00		$1,500 Title Guarantee and Trust Corp. 6% 1933 Certificate	1,500.00	
Bond interest	240.00		Cash in Savings Bank	129.01	
Bank interest	3.43		Due by Current Funds	1,314.98	
Interest on loan	19.33				
	5,671.29				
Deduct: Cost of Prizes	237.30				
		5,433.99			5,433.99
War Memorial Fund:					
Balance as at 1st January, 1934	4,022.55		$2,000 Dominion of Canada 4½% 1959 Bonds	2,000.00	
Add: Bond interest	218.57		$2,000 C.P.R. Collateral Trust Gold Bonds 5% 1954	1,995.00	
Bank interest	2.58		Cash in Savings Bank	268.91	
Profit on redemption of C.P.R. Bonds	20.21				
		4,263.91			4,263.91
		$13,068.93			$13,068.93

Gzowski Medal Committee

The President and Council:—

The committee would recommend that the Gzowski Medal for the prize year 1933-1934 be awarded to W. H. Powell, M.E.I.C., for his paper entitled "First Narrows Pressure Tunnel, Vancouver, B.C." published in The Engineering Journal for June 1934.

Respectfully submitted,
Robert W. Angus, M.E.I.C., *Chairman.*

Plummer Medal Committee

The President and Council:—

In the opinion of your committee, the Plummer Medal for 1933-1934 should be awarded to F. E. Lathe for his paper on "The Utilization of Magnesian Carbonates" as published in The Engineering Journal for December 1933.

Respectfully submitted,
L. F. Goodwin, M.E.I.C., *Chairman.*

Leonard Medal Committee

The President and Council:—

I beg to advise that the Leonard Medal Committee, 1934, of The Engineering Institute of Canada, has decided that the Leonard Medal should be awarded to D. E. Keeley, M.C.I.M.M., for his paper "Guniting at the McIntyre Mine" (June 1934 Bulletin of the Canadian Institute of Mining and Metallurgy).

Respectfully submitted,
J. G. Dickenson, M.E.I.C., *Chairman.*

Students' and Juniors' Prizes

The reports of the examiners appointed in the various zones to judge the papers submitted for the prizes for Students and Juniors of The Institute were submitted to Council at its meeting on January 18th, 1935, and the following awards were made:—

H. N. Ruttan Prize (Western Provinces)—No award.

John Galbraith Prize (Province of Ontario)—To F. A. Masse, Jr.E.I.C., for his paper "A History of Paper Making."

Phelps Johnson Prize (Province of Quebec, English)—To C. B. Charlewood, S.E.I.C., for his paper on "Steam Distribution in the Newsprint Mill."

Ernest Marceau Prize (Province of Quebec, French)—No papers received.

Martin Murphy Prize (Maritime Provinces)—No papers received.

Membership Committee

The President and Council:—

Your committee, which was appointed by Council in February 1933, has again continued its activities during the past year, presenting a mid-year report to Council on June 15th, 1934.[1]

It will be remembered that a membership campaign was instituted in the spring of 1933 and as a result a number of branches appointed special membership committees, while in other cases the branch executive committees undertook to act. The results of this campaign were presented to the Plenary Meeting of Council in October 1933.[2]

In April 1934, in accordance with the suggestions outlined in the above report the General Secretary communicated with all branches in university centres reminding them of your committee's suggestions which urged the desirability of The Institute members entering into closer relationship, if possible, with the undergraduates in the engineering schools, to whom the advantages of joining The Institute should be definitely presented during their college courses. Several other suggestions were made which it was hoped would prove helpful.

During the early part of the summer, in view of the intention of the President of The Institute and the General Secretary to visit the branches of The Institute, a communication was sent to all branches outlining the work of your committee to date, and forwarding a list of the names of those prospective members previously submitted in reply to the June 1933 circular, from whom applications had not yet been received. It was hoped that these names would again be canvassed and that the President and the Secretary during their visits to the branches would be asked for any information required.

Some very encouraging replies were received in reply to these letters and the chairmen and members of the various committees reporting are to be congratulated on their efforts.

A number of branch committees have also been active in canvassing members on the non-active list, in an endeavour to have them resume active membership, and in interviewing those intending to resign. Branch membership committees are reminded that during the sixty days that will elapse from the time their branch secretary receives a notification of a resignation and the time action is taken by Council to accept it, there is a good opportunity to ask the member concerned to reconsider his decision. Any suggestion of this kind, to be successful, must have the help of members of the branch executive or membership committees.

Elections and transfers during the past year show a marked improvement over the previous year and may be subdivided as follows:—

Elections—	Members	10
	Associate Members	41
	Juniors	12
	Affiliates	6
	Students	101
	Total	170
Transfers total		97

These totals of 170 elections and 97 transfers compare with 128 elections and 33 transfers during 1933.

Your committee believes that the reduced entrance and transfer fees have been of assistance in securing these improved results, along with the help offered to unemployed members, the increased activities of the student sections, and the personal visits to the branches of the President of The Institute and the General Secretary, this summer.

In the opinion of your committee continued activity by branch membership committees is essential, as while the increase in new members obtained during the past year is encouraging it is far short of the required three hundred estimated in the last report of your committee, as being the minimum necessary to make up for normal losses.

By far the best way to foster membership is for each member to contribute what he can in the way of technical papers or discussions, service on Institute or branch committees, and publicity in the press or elsewhere or among his friends and acquaintances regarding the essential and beneficial work that The Institute is doing. As a well-known advertising slogan has it "There is no substitute for quality." Furthermore it is the opinion of your committee that the success of The Institute will be enhanced by the co-operation of its branches and members with other societies that directly or indirectly promote interest in engineering matters, particularly the Associations of Professional Engineers, and also by a broader interest in national, provincial and municipal affairs and welfare generally.

Respectfully submitted,
D. C. Tennant, M.E.I.C., *Chairman.*

Papers Committee

The President and Council:—

Your Papers committee has not held a meeting during the past year and as a committee has done nothing. It is

[1] Engineering Journal, July 1934, p. 335.
[2] Engineering Journal, Feb. 1934, p. 79.

hoped, however, that each member has been of some assistance to the branches in his zone in obtaining papers for their branch meetings.

The difficulty encountered by some of the smaller and more isolated branches in obtaining interesting papers for their meetings, is accentuated in these times as funds cannot be found for the purpose of having speakers travel from larger centres. The chairman approached Mr. W. Storrie, M.E.I.C., of Gore, Nasmith & Storrie, with a view to having him stop off wherever possible on his proposed trip to the west in January. Mr. Storrie has some very interesting material and Mr. Durley is at present arranging with him to give a talk to as many of the branches as he can conveniently visit.

It is my opinion, which I believe is shared by the other members of the committee, that the main duty of this committee is for each member to try, in this way, to get papers from competent members passing through their zone on other business. This will eliminate a large part of the cost of obtaining papers of value.

It is suggested that the members of the committee should be kept informed by Headquarters whenever outstanding members of The Institute intend passing through their zone. The committee man of that zone could then communicate with such members with a view to having them visit the Branch and, if desired, present a paper. The individual members of the committee should also inform Headquarters when engineers of their zone are travelling to other zones.

In this way it is considered that not only would valuable papers be obtained but that the branches would receive much benefit from meeting men from Headquarters or from other zones.

Mr. Durley was able to obtain this year some very interesting moving picture films from England and it is thought that such films might be circulated with great benefit to the branches.

Respectfully submitted,
C. S. L. Hertzberg, M.E.I.C., *Chairman.*

Publication Committee

The President and Council:—

In view of the fact that the transactions of The Institute have not been published this year, your committee has to report that neither papers nor other matters have been submitted to it and that, therefore, it has been unnecessary to hold meetings.

Respectfully submitted,
Hector Cimon, M.E.I.C., *Chairman.*

Library and House Committee

The President and Council:—

The work of the library and information service has been carried on as extensively as the funds and staff available would permit. Your committee would draw attention to the increasing value for purposes of professional information of our files of back numbers of engineering periodicals and proceedings. The very small appropriation available is spent almost entirely on subscriptions to these periodicals, practically no books being purchased. For its accessions the library is dependent on donations so far as technical books are concerned.

The following are the statistics for library activities during 1934; the figures do not differ materially from those for 1933:—

Requests for information	617
Requests for text books, periodicals, reprints, etc.	487
Technical books borrowed	102
Bibliographies compiled for members	32
Accessions to library (largely reports, etc.)	597
Requests for photoprints	30
Total pages of photoprints furnished to members	169
Books presented for review by publishers	22

The headquarters premises have been maintained in good condition. After over twenty years' service it has been found necessary to make changes in some of the heating mains, renew a considerable portion of the electric wiring in the basement, and continue the renewal of portions of the exterior wood work, all at a cost of approximately $600.00.

Respectfully submitted,
A. Cousineau, A.M.E.I.C., *Chairman.*

Report of the E.I.C. Members of the Main Committee of the Canadian Engineering Standards Association

The President and Council:—

The Institute nominees on the Main Committee of the Canadian Engineering Standards Association are now as follows:—

Dean C. J. Mackenzie, M.E.I.C., retires March, 1935.
Mr. J. Morrow Oxley, M.E.I.C., retires March, 1936.
Mr. P. L. Pratley, M.E.I.C., retires March, 1937.

During the year a new Sectional Committee on Steel Construction has been organized, under which a Subcommittee on Procedure, Specifications and Standards, and Panels on Unit Stresses for Bridges, Unit Stresses for Buildings, and Structural Welding are now operating. The Subcommittee above referred to replaces the Joint Panel on Structural Steel for Bridges and Buildings which was reported last year.

Industrial conditions are still having their effect on the income of the Association. There have been five resignations from sustaining membership, and two sustaining members have felt compelled to reduce their subscriptions. To offset this, however, there have been added eight new sustaining members, one member has increased the subscription, and three former members have resumed membership. The total number of sustaining members and subscribers is now sixty-eight, and the total amount received for the year was $5,160, which is a reduction of only $40 from the amount received in 1933.

The Association continues to occupy quarters in Room 3064 of the National Research Building, through the courtesy of the National Research Council, and with other economies which have been effected the Association has thus been able to carry on for the year.

The Secretary attended the annual meetings of the Canadian Electrical Association and The Engineering Institute of Canada, and in May a joint meeting with the Standardization Committee of the American Railway Engineering Association was held, at which several of the officers and members of the Association were given an opportunity to give information on the work of the C.E.S.A.

At the Annual Meeting of the Association and at a meeting of the Main Committee, a proposed reorganization of the Main Committee was under discussion and it was decided to take this in hand actively. It is expected that a report from the Executive Committee will be sent out shortly for approval. The financial situation of the Association was also discussed, and it is hoped to put this on a more stable basis.

The publication of the C.E.S.A. Bulletin has been continued and is serving a very useful purpose. It has not been found possible to resume the publication of the Year Book, owing to lack of funds, but it is hoped that this can be resumed before long as it has been exceedingly valuable in promoting publicity for the work.

Work in Progress

A — Civil Engineering and Construction

Building Materials.—The Panel on Brick Sizes, after very carefully studying the situation, completed its report, and this has been generally approved by the Committee on Building Materials and is now before this Committee by letter ballot. The report recommends one size of brick for all purposes and includes suggestions for wall construction using the recommended size.

Close contact has been maintained with the committees dealing with the Toronto Building By-laws, and C.E.S.A. specifications will be recognized wherever possible.

Wood Poles and Piling.—As decided upon at the meeting of the Main Committee, arrangements will be made to merge the different committees on Wood Poles, and it is hoped to take up more actively during the coming year the question of standards for both eastern and western timber, also the proposed specification for piling.

B — Mechanical Engineering

Screw Products.—The standard for Non-heat-treated Machine, Carriage and Plough Bolts was issued in August, and it is believed that this standard now represents up-to-date practice in Canada. Information is given on the heavier type of Machine Bolts which are used in railroad practice, but this does not include track bolts. The latest information on wrench openings and nuts for the different types of bolts is also included, and the standard is strongly recommended for adoption by those interested.

No further action has been taken with reference to standards for Wood Screws and Small Rivets. It has been found difficult to get agreement on the proposed standard for Small Rivets and a final decision has not yet been reached.

Safety Code for Passenger and Freight Elevators.—The first draft and the comments thereon are still before the Committee, but a special panel has been organized to review these comments and prepare a revised draft and a report is not yet available.

Safety Code for Mechanical Refrigeration.—A committee has been organized to study this question, but it is possible that this work may be taken over by the National Research Council, who are studying the question of safety codes in general.

Oil Burners.—The Association has been advised that this work will probably be taken over by the National Research Council, but final arrangements have not yet been made.

C — Electrical Work

Canadian Electrical Code, Part I.—As a result of a meeting of the Special Committee on Code Revisions, held in March, the final revisions for the third edition have been approved by the Code Committee and also by the Sectional and Main Committee of the Association, and the third edition of the Code is now off the press and is being issued as the Canadian standard for 1935.

In connection with Part II of the Code, covering Approval Specifications, the specifications for Service Entrance and Branch Circuit-breakers, Capacitors (Electrical Condensers), Fractional Horsepower Motors, Electric Portable Lighting Devices and Outlet Boxes have been published and specifications for Motor-operated Blowers and Stokers and Electrical Equipment for Gasoline Measuring and Discharge Devices are now on the press. The specification for Electric Heating Pads is to continue in draft form until November 1st, 1935. Specifications for Insulated Conductors for Power-operated Radio Devices, Cable for Luminous-tube Signs and Oil-burner Ignition Equipment, and Soldering Lugs are now before the Code Committee for letter ballot. Revised drafts of the specifications for Enclosed Switches, Transformers for Luminous-tube Signs and Oil-burner Ignition Equipment, Industrial Control Equipment, Cord Sets and Oil Circuit Breakers are now before the Panel on Specifications for final approval. Specifications for Automatic Controllers of Small Capacity, Dust Tight Enclosures, Auxiliary Gutters, Junction Boxes and Pull Boxes, Wireways and Busways and Asbestos-insulated Stove Wire, have been out for comment and a summary of comments received is now before the Panel in preparation for meetings early in the year. First drafts of specifications for Panelboards, Enclosed Branch-circuit Cutouts, Switchboards and Switching Equipment, Electrically-operated Refrigerating Machines, Electric Cranes and Hoists and Electrode Receptacles for Luminous-tube Signs have been sent out for comment.

The publication of bulletins to electrical manufacturers has been continued, and five of these bulletins have been issued during the year, making a total of ten issued to date.

In connection with Part III of the Code, covering Outside Wiring Rules, some progress has been made, particularly in connection with the work of Sub-panel No. 3 on Inductive Co-ordination and Sub-panel 4 on Conductive Co-ordination. Under Inductive Co-ordination, the draft covering Definitions and Principles has been generally approved by the Panel on Outside Wiring Rules, and if approval can be obtained it is proposed to issue this in mimeograph form in the meantime. This also applies to the report on Principles and Practices Governing Radio Interference. A report on Conductive Co-ordination has been approved by the Panel on Outside Wiring Rules, and also by the Canadian Transit Association. No report is available on Underground Systems, but in connection with Sub-panel No. 1 on Overhead Systems, a report from the railway group on wire crossings was sent out for comment, also a preliminary draft on Overhead Systems, and comments on these documents are still being received.

Enamelled Magnet Wire.—It is hoped to have a second meeting of the Committee to discuss the second draft of this specification early in the year.

Insulated Power Cable.—A meeting of the Committee was held during the year and a complete revised draft has been sent out to the Committee for their comment. It is hoped to have a further meeting early in the year, at which it may be possible to secure approval of this draft.

Dielectric Strength and Insulation Resistance.—In the discussion of rules in Part I of the Canadian Electrical Code, and in the preparation of approval specifications under Part II of the Code, it has been found that there has been difficulty in securing uniform standards for dielectric strength and insulation resistance, and it has now been decided to organize a committee to deal with this subject and it is hoped to take this matter up actively early next year.

G — Ferrous Metallurgy

Heavy Steel Shaft Forgings.—At a meeting of the Committee held during the year, the revised specification was prepared and is still before the members of the Committee for comment.

Commercial Bar Steel.—It is believed that the existing C.E.S.A. specifications might be revised with advantage, and a circular has been issued to the Committee giving information on the situation and asking for suggestions as to future revisions.

Reinforcing Materials for Concrete.—Revisions to the three C.E.S.A. specifications are also being considered, and information has been sent out to the Committee asking for their comments.

S — Steel Construction

The Sub-committee on Procedure, Specifications and Standards has now reported, and four new specifications covering Medium Steel, Mild Steel, Silicon Steel and Rivet Steel have been prepared. The Sub-committee has also approved a report on proposed Unit Stresses for Bridges and Buildings. The specifications and the report will be presented to the Sectional Committee for approval and also to the Chairmen of existing C.E.S.A. Committees on Steel Railway Bridges, Steel Highway Bridges, and Steel

Structures for Buildings, for consideration, with the object of revising the C.E.S.A. specifications on bridges and buildings if necessary. A report on the Welding standards is not yet available.

CO-OPERATION AND PUBLICITY

Contact with the British Standards Institution, particularly with the work on approval specifications, has been continued and many helpful suggestions have been received.

As a matter of interest, the B.S.I. has issued a specification for Electric Signs, which has been largely inspired by the specification issued by the C.E.S.A.

The drafts of approval specifications are sent to the Underwriters' Laboratories at Chicago, and the Standardization Committee of the National Electrical Manufacturers Association at New York, and this contact has proved of great benefit.

The Association is again indebted to the technical press and newspapers for their generous co-operation in giving publicity to the work of the Association and the announcement of new publications.

The sale of publications has kept up well and there is every indication that they are being freely used throughout Canada.

The regular exchange of publications with the different standardizing bodies has been continued, particularly with the standardizing bodies of Great Britain and the other Dominions. A standardizing organization has now been established in Greece, and a set of C.E.S.A. publications has been sent to them for their information.

Respectfully submitted,
C. J. MACKENZIE, M.E.I.C.

Committee on Relations with National Societies

The President and Council:—

The Committee on Relations with National Societies has had a restful year.

We note that the International Electrotechnical Commission held a very good meeting at Prague, Czechoslovakia, in October, 1934. The attendance, as might be expected, was much smaller than usual; that condition, however, was not the fault of Great Britain—twenty-seven technical experts from the British Isles having been in attendance. All-America, which usually had from twenty to thirty representatives at these international gatherings—one or two, being the usual number of delegates from Canada—had one lone representative, Mr. R. E. Hellmund, from the United States National Committee.

An effort is being made to hold a large Plenary Meeting with Belgium and Holland combining as host-countries, next year.

The success of the *international* Prague meeting, coming as it did at "an exceptionally difficult period of world depression and extreme economic 'nationalism'," seems to be worth recording.

Respectfully submitted,
JOHN MURPHY, M.E.I.C., *Chairman.*

Board of Examiners and Education

The President and Council:—

The results of the examinations held during 1934 for admission to The Institute are as follows:—

Description	*No. of Candidates*	*No. of Papers Written*	*No. of Passed*	*Papers Failed*	*No. of Candidates Completely Passed*
Examined under Schedule "B" (Junior)...........	1	1	..	1	..
Examined under Schedule "C" (Associate Member)—					
Structural Engineering......	1	3	1	2	..
Electrical Engineering......	1	2	2	..	1
Metallurgical Engineering......	1	2	1	1	..

Your Board also reported favourably on the standing of the examinations set by the Institution of Electrical Engineers of Great Britain, and also on the standing of the engineering undergraduates attending the Memorial University College, St. John's, Newfoundland.

Respectfully submitted,
A. F. DYER, A.M.E.I.C., *Chairman.*

Unemployment Committee

The President and Council:—

Your committee wishes to report regarding its work during the year 1934. Before doing so, however, a short summary of activities to date may be of interest.

The apointment of this committee was first made by Council on April 15th, 1932, when, due to unsatisfactory conditions throughout Canada, it was felt that Council should have reliable data as to the extent of unemployment among the members of The Institute. Your committee's first step was to make a general survey of the membership and as a result of its findings[1] The Institute branches were requested to form local committees to assist unemployed members in their districts.

Since that time these committees have been of great assistance to those unemployed in locating positions. They have supervised relief payments where necessary, and have enabled your committee to keep in touch with conditions in the various branches.

In September 1933 further enquiries were made of all branches as to the number then known to be unemployed and in need of relief. The information received was presented to the Plenary Meeting of Council in October 1933.[2] The report also included particulars of 133 placements on the supervisory staffs of the Department of National Defence Relief Camps. These openings were at that time, and have since, proved to be of great assistance to many of our members in need of relief.

In April 1934, believing that possibly there was more unemployment among our members than the registration at headquarters indicated, your committee again communicated with all branches requesting a check on the members known to be unemployed or in need of relief, and data regarding expenditures for relief and any other pertinent information available.

As a result of the replies received it was possible to report to a meeting of Council on June 15th,[3] that it was estimated there had been a reduction in unemployment among members of approximately 25 per cent. This reduction was apparently greater among our own members than among engineers generally, also some localities were better than others. At that time, however, the number registered with The Institute Employment Service Bureau had not diminished, as the 1934 engineering graduates had just been added to our lists. A considerable improvement was shown on January 1st, 1935, however, with 334 registered, as compared with January 1st, 1934, when the number was 384, of whom some 35 per cent are actually employed in temporary or part time work.

In order that up-to-date information might be available for your committee's annual report, a further communication was sent to all branches in November 1934, enclosing a list of those in each branch then registered as unemployed at headquarters and requesting particulars of the activities of their unemployment committees during the year. At the same time headquarters communicated with all those registered with the Employment Service Bureau who had not been heard from for some time; as a result of this check and other placements, it has been possible to reduce the number registered to that mentioned above.

[1] Engineering Journal, July 1934, p. 335.
[2] Engineering Journal, December 1933, p. 528.
[3] Engineering Journal, July 1934, p. 335.

Sixteen branches returned a report of their activities and from an examination of these it would appear that no branches other than Toronto, Kingston and Montreal had members in immediate need of relief, or had found it necessary to make an expenditure for relief purposes. Montreal had the largest expenditure, amounting to $1,208.60, members of the branch subscribing $710 during the year to a special fund for relief purposes. Other branches found it unnecessary to add to previous contributions, or utilized surplus branch funds. A synopsis of the comments received from the branch committees appear as follows:—

Cape Breton—Steady improvement. Prospects better than they have been for some time.

Halifax—Prospects for employment during winter and spring not very good. Recent mining activity has helped situation but construction at low ebb.

Saint John—Prospects for employment during winter are not very bright particularly for students. For the spring, highway construction would appear to be the only work in view.

Quebec—Number of unemployed have decreased and conditions seem to be improving.

Montreal—Considerable decrease in the number of unemployed, but little demand for more experienced men at present.

Ottawa—Slightly improved conditions but prospects for 1935 not definite. Fourteen engineers in district have left positions on the supervisory staffs of the Department of National Defence Relief Camps to take more remunerative positions.

Kingston—Employment meagre during winter. The last eighteen months would have been disastrous except for the Department of National Defence Unemployment Relief Camps.

Peterborough—Conditions are brighter than for some years.

Toronto—Employment situation has improved, very few requests for assistance from Loan Fund.

Niagara Peninsula—Considerable number of engineers unemployed, or employed in other lines. Poor prospects for further employment on either public works or industrially during winter. Spring prospects will vary with amount of local public works allocation.

Border Cities—Employment prospects for winter and spring much better than a year ago.

Saskatchewan—Possibly some improvement, but very slight.

Lethbridge—Expect sufficient employment for all members without relief assistance.

Edmonton—At present rather quiet but expect considerable temporary employment will be available in the spring.

Vancouver—Present engineering employment in British Columbia rated at not higher than 50 to 60 per cent of normal.

Victoria—Situation slightly better than last winter. No immediate prospects for employment other than Department of National Defence Unemployment Relief Camps.

From the above reports it would appear that nearly all branches find conditions somewhat improved. Several, however, expressed the hope that both Federal and provincial governments would endeavour to carry out as large construction programmes as possible in the near future with a view to relieving unemployment.

It has been hoped that the programme of work being undertaken by the Federal Public Works Department would provide employment on their staffs for a number of engineers. However, the department was able to carry out their programme with very few additions to their staff.

A satisfactory indication of improved conditions is the heavy outflow of engineers from the Relief Camps of the Department of National Defence, many of whom are known to have gone to better positions. Throughout Canada over one hundred engineers, or over one-half of the number employed on the supervisory staffs, have left the camps during the past year.

Council's Committee on Unemployment desires to thank all Branch Executives and Branch Unemployment committees for the good work already accomplished. They wish to record also their appreciation of the co-operation shown in a number of centres by the Associations of Professional Engineers in assisting in relieving unemployment. The work of Colonel R. E. Smythe, A.M.E.I.C., chairman of the Toronto Branch Unemployment committee, should be particularly mentioned. Finally, they wish to express their thanks to all who contributed towards the actual relief of needy cases.

Your committee has understood its purpose to be the finding of work and the helping of needy unemployed engineers by supporting and co-ordinating the efforts of the various branch committees and feel that this work may have to continue for some time yet owing to the uncertainty still prevalent in business generally.

Respectfully submitted,

D. C. Tennant, M.E.I.C., *Chairman.*

Employment Service Bureau

The President and Council:—

The Employment Service Bureau of The Institute is able to report an improvement in employment conditions, as will be seen by the following figures for placements effected during the last four years:—

1931	*1932*	*1933*	*1934*
33	58	50	70

The following figures show the extent of the Bureau's work for 1934 as compared with 1933:—

	1934	*1933*
Number of registrations during the year—members	102	138
Number of registrations during year—non-members	39	46
Number of members advertising for positions	115	102
Replies received from employers	56	21
Vacant positions registered	124	92
Vacancies advertised	16	4
Replies received to advertised vacancies	59	16
Men notified of vacancies	139	147
Men's records forwarded to prospective employers	446	210
Placements — temporary and permanent — definitely known	70	50

The above placements do not include eleven members and four non-members placed on the Supervisory Staffs of the Department of National Defence Unemployment Relief Projects, in which the Employment Service Bureau worked in conjunction with the Branch Unemployment Committees.

At the present time 334 members are registered with the Employment Service Bureau, 95 of whom are temporarily employed and 29 employed with the Department of National Defence Unemployment Relief Camps.

The principal demand has been for mechanical engineers with pulp and paper mill experience, draughtsmen in the same line, plant engineers, and chemical, metallurgical and mining engineers. There have been a number of enquiries for sales engineers, but in several cases on a commission basis only, which accounts for a number of the unfilled vacancies.

The bureau has been instrumental in placing a number of 1933 and 1934 graduates in mechanical, electrical and chemical engineering, mainly in the Montreal district, and at the present time comparatively few recent graduates in mechanical and chemical engineering are registered with the bureau. At this point may we point out to members the advantages of being registered with the bureau. When we are notified of a vacant position prompt action is necessary so that only the records of experience of members already on file can be forwarded to the prospective employer. Usually there is not time even to notify the members of the vacancy before sending out their records for consideration.

In some cases a registrant's engineering record has been sent out in this way as many as ten times without his knowledge; thus as a rule members are not aware of the extent of service received through having their names and records on file with the bureau.

In December 1934 a questionnaire was sent to all members registered with the Employment Service Bureau, with whom we had not been in communication for some time, in order to ascertain if they had secured employment.

One hundred and ninety-three letters were sent out and replies have been received as follows:—

22 have secured employment and wish their names removed.

48 have secured temporary employment in engineering and otherwise but wish their names retained on the list of men available.

45 are still unemployed.

The above information is felt to be distinctly encouraging and should employment conditions continue to improve as now seems likely, it will be possible to place many more of our unemployed members.

Respectfully submitted,

R. J. Durley, M.E.I.C., *General Secretary.*

Branch Reports

Border Cities Branch

The President and Council:—

The Executive committee of the Border Cities Branch, Engineering Institute of Canada, submits the following report for the calendar year 1934.

The Executive committee has held seven meetings for the transaction of business during the past year.

Eight regular dinner meetings and one special meeting were held as follows:—

1934

Jan. 12.—**The Diesel and High Speed Engines** by Boyd Candlish, A.M.E.I.C., of the Palmer Bee Co., Detroit. Attendance, 36.

Feb. 16.—**A Trip Through the Past** by Mr. Ernest Wilby, A.A.I.A., Professor of Architecture at the University of Michigan, Ann Arbor. Attendance, 22.

Mar. 9.—**The Development of Cementing Materials and Architectural Concrete from Earliest Times** by J. M. Breen, A.M.E.I.C., technical engineer of the Canada Cement Co., Montreal. Attendance, 20.

April 20.—**An Adventure in Politics** by S. E. McGorman, M.E.I.C., of the Canadian Bridge Co., Walkerville, and Mayor of Ojibway. Attendance, 26.

May 18.—**The Design and Construction of the Dominion Public Building in Windsor** by Mr. H. P. Sheppard, of Sheppard and Masson, architects. Attendance, 17.

May 25.—Visit to the Dominion Public Building conducted by Mr. H. P. Sheppard. Attendance, 27.

Oct. 19.—**The Electronic Valve** by Mr. George Chute, of the General Electric Co. Attendance, 28.

Nov. 16.—**Gasoline** by Mr. J. M. Miller, of the Standard Oil Co. of Indiana. Attendance, 30.

Dec. 14.—**Construction of a Steel Plant in Russia** by Mr. M. J. Wohlgemuth, of the Westinghouse Electric Co. Attendance, 50.

The average attendance at regular meetings was 29.

The papers submitted throughout the year have been of a high standard. We are glad to announce that our papers committee has secured speakers for each meeting up to the close of the winter season.

Membership

The membership of the Branch is made up as follows:—

	Resident	*Non-Resident*	*Total*	*Non-Active*
Members	12	2	14	3
Associates	25	7	32	9
Juniors	1	2	3	..
Students	9	4	13	..
Affiliates	1	..	1	..
	48	15	63	12

A comparison of our present membership with that of other years is shown in the following table:—

	1930	*1931*	*1932*	*1933*	*1934*
Members	23	24	21	17	14
Associates	50	53	42	34	32
Juniors	12	12	8	5	3
Students	16	15	11	11	13
Affiliates	1	1	1	1	1
	102	105	83	68	63

Financial Statement

(For the year ending December 31st, 1934)

Receipts

Balance on hand, January 1st, 1934	$ 68.13	
Rebates on dues, October, November, December, 1933	10.35	
Rebates on dues, January to September (incl.), 1934, less exchange	104.40	
Rebates on expenses account plenary meeting, less exchange	69.85	
Dinner receipts	66.00	
Rebates on dues, October, November, December, 1934	14.40	
		$333.13

Expenditure

Printing	$ 39.32	
Stamps and telegrams	3.63	
Typing	11.00	
Telephone	.70	
Meals	94.50	
Flowers	15.00	
Miscellaneous	9.70	
Balance on hand in bank	144.88	
Accounts receivable	14.40	
		$333.13

Respectfully submitted,

H. J. A. Chambers, A.M.E.I.C., *Chairman.*

C. F. Davison, A.M.E.I.C., *Secretary-Treasurer.*

Calgary Branch

The President and Council:—

On behalf of the Executive committee of the Calgary Branch, we are happy to anounce considerable progress during the past year.

The following report covers the activities of our Branch from January 1st to December 31st, 1934.

Membership

	December 31st, 1934		
	Resident	*Non-Resident*	*Total*
Members	16	8	24
Associate Members	46	13	59
Juniors	3	1	4
Students	13	4	17
Branch Affiliates	10	..	10
	88	26	114

It is with deep regret that we have to report the passing of B. S. Smith, Affil.E.I.C., on May 16th, 1934.

During the year we have added seven associate members, one of which was a transfer from junior grade, and one transferred from another branch, while three students were added.

Several applications are pending for membership in various grades.

The Executive committee met nine times during the year to deal with and dispose of the various items which arose. An Unemployment committee dealt with all questions pertaining to that activity.

General Meetings

Fifteen general meetings were held, and the interest and attendance at each were a marked success. The papers and discussions were particularly interesting and timely. Among the many subjects, one innovation proved a decided success, i.e., Students and Juniors competition for a handsome cash prize, and so successful was this feature from every standpoint, that one of our members donated a prize for a similar competition this season, of which two papers have already been delivered, and several others will be given at intervals during the winter.

1934

Jan. 11.—**Construction of the Big Bend Highway in British Columbia by the National Parks of Canada** by J. M. Wardle, M.E.I.C., Banff. Attendance, 100.

Jan. 25.—**Engine 8000** by Mr. T. F. Donald, C.P.R., Montreal. Attendance, 110.

Feb. 15.—Joint dinner with Professional Engineers of Alberta and the Canadian Institute of Mining and Metallurgy. Attendance, 64.

Mar. 1.—Students Competition:

1st. **Construction and Principals of Operation of the New Sewage Disposal Plant at Bonnybrook.**

2nd. **The Application of Heavisides Operational Calculus to Engineering Problems.**

Mar. 2.—Continuation of Students Competition:

3rd. **Railway Construction in the Peace River Block.**

4th. **Recent Developments in Radio Receiver Design.** Attendance, 85.

May 3.—**Construction and Operation of the British Grid System** (3 reels) and introductory address by G. H. Thomson, A.M.E.I.C., general manager, Calgary Power Co. Attendance, 60.

May 25.—**Construction of Power Lead Across the Desert from the Boulder Dam** and **Construction of Cable** (6 reels), courtesy of Canada Wire and Cable Co. Attendance, 35.

May 26.—Inspection of Engine 8000 at Ogden Shops, courtesy of C.P.R. and Mr. T. F. Donald. Attendance, 20.

July 23.—Complimentary dinner to our President, F. P. Shearwood, M.E.I.C., and address on **Bridge Erection** by F. P. Shearwood, M.E.I.C., Montreal, chief engineer, Dominion Bridge Co. Attendance, 35.

Sept. 15.—Golf Tournament. Attendance, 35.

Oct. 18.—**From the Ground Up** (5 reels). Attendance, 76.

Nov. 1.—Contest open to Corporate, Junior and Student members—two papers.
1st. **Photo Electric Cells and Some of their Applications.**
2nd. **Pressure Vessels for Cracking Oil.**
Also address **Timber Design, Working Stresses and Preservative Treatment** by W. H. Greene, M.E.I.C., chief engineer, Canada Creosoting Co. Ltd.
Attendance, 45.

Nov. 15.—**Land Utilization and Farming Problems on Irrigated Projects** by R. S. Stockton, M.E.I.C., C.P.R., D.N.R., Experimental Farm, Strathmore.
Air Conditioning by W. B. Trotter, A.M.E.I.C.
Attendance, 50.

Nov. 29.—Supper Dance. Attendance, 85.

Dec. 13.—**Commercial Air Transport** by A. Griffin, M.E.I.C., chief engineer, C.P.R., D.N.R., Brooks.
Activity at Vickers Armstrong Ltd., Barrow-in-Furnace (6 reels).
Attendance, 110.

Average attendance at meetings, 62.5.

Financial Statement

Receipts

Cash in bank, January 1st	$111.38	
Interest and savings	47.25	
Rebates	189.88	
Application fees	74.00	
Sale of bond	100.00	
Entertainments	46.30	
		$568.81

Expenditures

Application fees to Headquarters	$ 47.00	
Purchase of bond	98.96	
Meetings	121.03	
Stamps and printing	72.81	
Entertainment	96.23	
Miscellaneous	29.00	
Balance in bank	103.78	
		$568.81

Assets
(As at January 1st, 1935)

Cash in bank	$103.78	
Bonds (market value)	968.00	
Rebates of Members fees in arrears	23.70	
		$1,095.48

Audited and found correct,
P. A. Fetterly, A.M.E.I.C.
W. T. McFarlane, A.M.E.I.C. } Auditors.

Respectfully submitted,
G. P. F. Boese, A.M.E.I.C., *Chairman.*
John Dow, M.E.I.C., *Secretary-Treasurer.*

Cape Breton Branch

The President and Council:—

The annual report of the Cape Breton Branch is as under.

During the year the Branch held four meetings as follows:—

1933

Dec. 19.—Annual Meeting and Banquet at which H. M. Roscoe, of Canadian Industries Limited, read a paper on **The Manufacture and Use of Explosives.** This paper was illustrated and gave rise to much discussion. Attendance, 33.

1934

Jan. 16.—General meeting held, by invitation, at the Royal Cape Breton Yacht Club, and addressed by Major J. W. Maddin on **Some Engineering Problems of Nova Scotia.** Attendance, 53.

Feb. 20.—General meeting at which H. C. Carlton, of Reyrolle Co., gave an illustrated paper on **The Development of Metal-clad Switch Gear.** Attendance, 28.

April 3.—General meeting at which G. B. Mitchell, M.E.I.C., of the Atlas Construction Co., gave some reminiscences of his work in Central and South America. Attendance, 19.

Due to the difficulty of getting speakers we have not been able to hold meetings during the fall months but it is expected that monthly meetings will be resumed throughout the winter. We much regretted that on his Maritime visit the President could not afford the time to visit us.

Financial Statement

Receipts

Balance brought forward	$276.50	
Rebates from Headquarters	46.60	
Sale of tickets for Annual Meeting	31.00	
		$354.10

Expenditures

Annual meeting	$ 80.85	
Printing notices of meetings	6.25	
Other expenses at meetings	2.15	
Telegrams	2.91	
Stamps and secretarial expenses	13.70	
Balance on hand	248.24	
		$354.10

Audited and found correct,
S. G. Naish
R. R. Moffatt } Auditors.

Respectfully submitted,
C. M. Smyth, M.E.I.C., *Chairman.*
Sydney C. Mifflen, M.E.I.C., *Secretary-Treasurer.*

Edmonton Branch

The President and Council:—

On behalf of the Executive committee of the Edmonton Branch we beg to submit the following report for the year 1934.

Membership

	Dec. 31st, 1933 Resident	Non-Resident
Members	11	2
Associate Members	23	6
Junior Members	3	..
Student Members	33	..
	70	8

	Dec. 31st, 1934 Resident	Non-Resident
Members	10	3
Associate Members	18	6
Junior Members	5	..
Student Members	26	..
	59	9

It is with deep regret that we record the loss of W. J. Cunningham, A.M.E.I.C., an esteemed member of this Branch, and Mr. G. Law, who until recently was an active member of the Branch. Both these gentlemen passed away during the course of the year.

Meetings

The following meetings of the Branch were held during the year:—

1934

Jan. 9.—**Television and the Sending of Pictures by Wire** by Mr. A. M. Mitchell, Comptroller of the Alberta Government Telephones. Attendance, 35.

Feb. 6.—**The Century of Progress** by C. E. Garnett, A.M.E.I.C., of Gormans Ltd., Edmonton. Attendance, 18.

Mar. 14.—**Domestic Waters** by Mr. W. Calder, Director of the Petroleum and Natural Gas Division, Department of Lands and Mines, of the Alberta Provincial Government. Attendance, 24.

May 2.—A film showing the **Development of the New Super-Power Transmission System in Great Britain.** Attendance, 30.

Oct. 24.—**Development of Flying in the North Country** by Mr. C. H. Dickins, Superintendent of Canadian Airways, Ltd., Western Lines. Attendance, 40.

Nov. 20.—Films loaned to the E.I.C. by Vickers-Armstrong, Ltd., and dealing with **Steelmaking, Aviation and Shipbuilding.** Attendance, 21.

Three meetings of the Executive committee were held to deal with special questions which arose.

Financial Statement

Receipts

Balance on hand, January 1st, 1934	$197.55	
Rebates from Headquarters	73.50	
Rebates due from Headquarters, December 31st, 1934	14.55	
Surplus from 1933 Special Unemployment Relief Fund	2.00	
		$287.60

Expenditures

Expenses of meetings	$ 36.25	
Postage	7.00	
Printing	16.77	
Honorarium to Secretary-Treasurer	50.00	
⅓ expenses of Branch Chairman to Western Professional Meeting of E.I.C., July 11th to 14th	31.20	
Miscellaneous—telegrams, flowers, express	11.97	
Accounts receivable	14.55	
Balance on hand, December 31st, 1934	119.86	
		$287.60

Edgar Stansfield, M.E.I.C. }
M. L. Gale } Auditors.

Respectfully submitted,
H. R. Webb, A.M.E.I.C., *Chairman.*
R. M. Hardy, S.E.I.C., *Secretary-Treasurer.*

Halifax Branch

The President and Council:—

On behalf of the Chairman and Executive of the Halifax Branch the following report is submitted for the year 1934.

Including the Annual Meeting there have been eight regular meetings and eight meetings of the Executive. The following meetings were held:—

January.— Annual banquet held in conjunction with the Nova Scotia Professional Society of Engineers.

February.— Meeting at Halifax hotel addressed by E. H. James, M.E.I.C., consulting engineer, of Montreal, on **Marine Substructures.**

March.— Meeting at Halifax hotel addressed by Mr. W. B. Burchall of Canadian Airways on **The Development of Canadian Airways.** Attendance, 40.

July.— Summer meeting at Green Acres, Waverley, N.S. Attendance, 75.

October.— Students meeting. Showing of films loaned by Vickers-Armstrong Ltd. Attendance, 250.

December.— Meeting at Halifax hotel addressed by President F. P. Shearwood, M.E.I.C., on matters of interest to members of The Institute. Attendance, 45.

December.— Meeting at the Nova Scotia Technical College addressed by President F. P. Shearwood, M.E.I.C., on **Some Problems of Bridge Design and Construction.** Attendance, 125.

The Executive arranged for a series of broadcasts over the local radio station during the year. These broadcasts were on subjects of engineering interest intended to enlighten the public regarding the engineering profession.

1.—E. L. Miles, M.E.I.C., Standard Paving Company (N.S.), gave a general discussion on **Roads and Road Construction and Dustless Highways.**

2.—H. S. Johnston, M.E.I.C., chief engineer, Nova Scotia Power Commission, gave a general talk on **Hydro-Electric Stations in Nova Scotia.**

3.—I. P. MacNab, M.E.I.C., Public Utilities Commission, gave a general outline of the Public Utilities Act and a discussion as to how it applies to the various utilities in Nova Scotia.

4.—W. A. Winfield, M.E.I.C., general superintendent of plant, Maritime Telegraph and Telephone Company, gave a general talk on the dial telephone and its application in Nova Scotia.

5.—G. V. Douglas, A.M.E.I.C., professor of Geology at Dalhousie University, gave a general talk on **The Geology of Nova Scotia.**

6.—W. P. Copp, M.E.I.C., professor of Civil Engineering at Dalhousie University, gave a general talk on **Surveying and the Method of Determining Boundaries of Lands.**

7.—J. B. Hayes, A.M.E.I.C., general manager of the Nova Scotia Light and Power Company, gave a talk on the service given by his company to the people of Nova Scotia.

8.—J. Morris, sales engineer of Wm. Stairs, Son and Morrow, Limited, gave a general talk on **Diesel Engines.**

9.—W. B. MacKay, A.M.E.I.C., managing director of Farquhar Bros. Ltd., gave a talk on **Modern Heating Systems.**

Arrangements were made for a joint meeting of representatives of the Halifax Branch and of the Nova Scotia Society of Professional Engineers at which the general subject of amalgamation was discussed and a general policy for further action was recommended to both Societies.

Suggestions to other Maritime Branches regarding interchange of speakers have been made to other Branches of The Institute and it is hoped satisfactory arrangements can be made during the coming year.

The average attendance at meetings was greater than during the past few years and it is interesting to note that a number of the younger members are taking a more active interest in the affairs of the Branch.

The finances of the Branch are in good shape and the audited statement shows an operating balance for the year of $26.98, making the total cash on hand at the close of the year 1934—$455.95.

Respectfully submitted,
R. L. Dunsmore, A.M.E.I.C., *Chairman.*
R. R. Murray, A.M.E.I.C., *Secretary-Treasurer.*

Hamilton Branch

The President and Council:—

The Executive committee of the Hamilton Branch submits the following report for the calendar year 1934:—

The Executive committee held 11 meetings throughout the year. The following is the list of professional meetings and visits:—

1934

Jan. 9.—Branch Annual Business Meeting.
Operation and Application of the Teletypewriter by R. A. Cline, equipment engineer, Bell Telephone Co. Attendance, 50.

Feb. 13.—**Activities of the Ontario Research Foundation** by O. W. Ellis, Director of Metallurgical Research, Ontario Research Foundation. Attendance, 45.

Mar. 1.—Joint Meeting with the Toronto Branch E.I.C. in Toronto.
The Status of the Engineer in Industry by a Committee of the Hamilton Branch, J. B. Carswell, M.E.I.C. (chairman), E. P. Muntz, M.E.I.C., H. B. Stuart, A.M.E.I.C. Attendance, 100.

Mar. 17.—Visit to the Plant of the Sovereign Potteries Ltd., Sherman Ave. N., Hamilton. Members and ladies. Each lady was the recipient of a cup and saucer, specially made for the occasion, and bearing The Institute crest. Attendance, 125.

April 6.—Joint Meeting with the Toronto Section A.I.E.E. in the Canadian Westinghouse auditorium.
Circuit Interruptions by Dr. Joseph Slepian, consulting engineer, Research Laboratories, Westinghouse Electric and Manufacturing Co., Pittsburgh. Attendance, 195.

May 8.—**Corrosion and Wire Galvanizing** by A. B. Dove, Jr.E.I.C.
Manufacture and Application of Wire Rope by C. D. Meals, wire rope engineer, B. Greening Wire Co., Hamilton.
Attendance, 70.

June 9.—Visit to new Soaking Pit Building, Dominion Foundries and Steel Ltd., Hamilton. A 100 per cent made-in-Canada building. Attendance, 30.

Sept. 18.—Joint Meeting with the Hamilton Chemical Association.
The X-ray in Industry by Dr. L. R. Hess. Attendance, 150.

Oct. 9.—**The Geology of the Gold Fields of Ontario** by Dr. E. M. Burwash, geologist, Provincial Department of Mines, Toronto. Attendance, 75.

Oct. 26.—Joint Meeting with the Babcock-Wilcox and Goldie-McCulloch Engineering Society, Galt.
Moving pictures showing the Boulder Dam Construction on the Colorado River. Attendance, 250.

Nov. 1.—Joint Meeting with the Toronto Branch E.I.C. at Toronto.
Moving Pictures descriptive of work done at the plants of the Vickers-Armstrong Co., England. Attendance, 150.

Nov. 20.—**An Engineer in Nigeria** by T. Stanley Glover, A.M.E.I.C. Attendance, 60.

The professional meetings of the Branch have introduced a wide variety of subjects, which proved very attractive. The second committee paper sponsored by the Branch was read at a joint meeting in Toronto and aroused a great deal of interest and favourable comment. Two of our own members—A. B. Dove, Jr.E.I.C., and T. Stanley Glover, A.M.E.I.C.—gave papers before the Branch and proved themselves most attractive speakers.

The Branch has again enjoyed the privilege of holding its meetings in the Science Hall, McMaster University, where accommodation for lecture and demonstration is of the best. We appreciate the kindness of the University authorities in granting this privilege and in doing everything possible to make us comfortable.

The Executive committee acknowledges its indebtedness to the local press for the many courtesies extended to the Branch throughout the year.

The books of the Branch have been placed in the Hamilton Public Library. After being catalogued they will be placed in the reference room, but may be taken out on a borrower's card by any member on presentation of a card, signed and stamped by the Secretary.

E. H. Darling, M.E.I.C., represents the Branch on the committee revising the City of Hamilton Building By-laws.

H. B. Stuart, A.M.E.I.C., represents the Branch on the Regional Committee of the National Construction Council.

Membership

	Dec. 31st, 1933		
	Resident	*Non-Resident*	*Total*
Members	28	6	34
Associate Members	40	10	50
Juniors	10	3	13
Students	31	3	34
Affiliates	2	..	2
Branch Affiliates	16	..	16
	127	22	149

	Dec. 31st, 1934 Resident	Non-Resident	Total
Members	27	3	30
Associate Members	33	10	43
Juniors	8	2	10
Students	26	3	29
Affiliates	2	..	2
Branch Affiliates	17	..	17
	113	18	131

In addition to the above we have on the non-active list, 1 Member, 11 Associate Members, 4 Juniors and 2 Students.

FINANCIAL STATEMENT

Income

Balance in bank, January 1st, 1934	$ 49.87	
From Headquarters (due for 1933)	32.87	
Branch Affiliates	60.00	
Rebates on fees	198.30	
Interest	55.76	
		$396.80

Expenditure

Printing and postage	$ 76.36	
Meeting expenses	101.75	
Travelling expenses	79.20	
Headquarters for Journals—paid us in 1933	4.00	
Section of filing cabinet	5.75	
Stenographer	50.00	
Sundry	1.80	
Balance in bank, December 31st, 1934	54.54	
Due from Headquarters (rebates for last quarter)	23.40	
		$396.80
Net income	$314.06	
Net expenditure	318.86	
Net operating loss	$ 4.80	

Assets

Bonds at cost	$915.00	
Lantern (less depreciation)	105.00	
Bank balance	54.54	
Due from Headquarters	23.40	
		$1,097.94

Respectfully submitted,

H. B. STUART, A.M.E.I.C., *Chairman.*
ALEX. LOVE, M.E.I.C., *Secretary-Treasurer.*

Kingston Branch

The President and Council:—

During the year 1933-34 the Kingston Branch met four times as follows:—

1933

Oct. 24.—Annual Dinner and Meeting for the election of officers and for receiving reports.

1934

Jan. 17.—The Branch was honoured by a visit from the President of The Institute, Dr. O. Lefebvre, M.E.I.C., who was tendered a dinner at the Badminton Club, following which he gave a very interesting talk on **The Activities of The Institute.**

Feb. 15.—A film of the Abitibi Power Development was lent to the Branch by the Dominion Construction Co.

Mar. 1.—A paper on **The History and Development of the Military Tank** was presented by Lt.-Col. N. C. Sherman, M.E.I.C., R.C.O.C.

EMPLOYMENT

The situation as regards employment continues to be very discouraging for a few members of our Branch, and it is hoped that any having work to offer will give the first opportunity to members of The Institute.

MUNICIPAL AFFAIRS

No meetings of the International Bridge Committee were held during the year. The committee appointed to confer with the city authorities on the subject of sewage held one meeting with the Mayor, with inconclusive results.

MEMBERSHIP

	Hon. Members	Members	Assoc.	Juniors	Students
1931-32	1	12	17	6	7
1932-33	1	13	16	6	16
1933-34	1	11	19	7	14

FINANCIAL STATEMENT

The financial statement is appended below. It should be noted that as no payment is now made by The Institute for Branch News, the only source of revenue for the Branch is the rebate from dues. The failure of even three or four members to pay their annual fees becomes a serious matter to so small a branch.

During the year, the attention of your secretary was called to the fact that about fifteen years ago $50 was advanced to the Branch by The Institute. Inquiries to previous secretaries confirmed this, and the amount is now shown in the statement of assets and liabilities.

Receipts

Balance last account	$ 63.50	
Annual dinner	.65	
Rebates	12.45	
Branch News	2.88	
Interest	.65	
Rebates	64.20	
Interest	.09	
		$144.42

Expenditures

Guest	$ .75	
Loan to member	50.00	
Plenary Council	8.15	
Dinner, Dr. Lefebvre	8.10	
Dinner	2.50	
Stamps	.25	
Telegram	.37	
Printing	5.82	
Stamps and telegram	1.00	
Chamber of Commerce	15.00	
Balance	52.48	
		$144.42

Assets

Cash in bank	$ 52.48	
Loan to member	50.00	
		$102.48

Liabilities

Owing to General Funds E.I.C.	$ 50.00	
Balance	52.48	
		$102.48

Respectfully submitted,

W. CASEY, M.E.I.C., *Chairman.*
L. F. GRANT, M.E.I.C., *Secretary-Treasurer.*

Lakehead Branch

No report received.

Lethbridge Branch

The President and Council:—

The following is a report of the operations of the Lethbridge Branch during the year 1934.

Since January 1st, 1934, 8 regular and 8 executive meetings have been held, attendance at the former averaging 40 and at the latter 7.

The usual procedure was followed in connection with our regular meetings, i.e. dinner meetings with short musical programmes interspersed with community singing, followed by an address or films.

It is becoming more difficult every year to secure material for programmes. Speakers are hard to secure and usually if an outside speaker is available the Branch is liable for some of his expenses, which under the present conditions they find hard to meet. We have had some very good films this year and The Institute are to be commended for securing the "British Grid System" and the "Vickers-Armstrong." The Programme committee have worked hard, and are to be congratulated on securing a well balanced programme.

Through the efforts of an active Entertainment committee the musical and social end of our meetings have been well up to average.

During the first six months of this year, due to low finances, no set schedule of meetings was followed and interest in Branch and Institute affairs seemed to lag; as a result it was decided to operate as before, with a set programme and admitting Branch Affiliates at a reduced rate of $2 providing they paid their fees before March 1st.

The list of speakers and subjects chosen follows:—

1934

Feb. 17.—Motion pictures on **Manufacture of Cotton** loaned by Dominion Textile Ltd. Open to ladies. Attendance, 65.

Mar. 15.—Annual Meeting. Attendance, 10. Very bad weather, unexpectedly.

June 4.—Motion pictures on **British Electrical Grid System** loaned by British Electrical Board. Attendance, 60.

July 20.—F. P. Shearwood, M.E.I.C., President Engineering Institute of Canada, **Bridge Erection** and **Institute Affairs.** Attendance, 19.

Oct. 13.—J. M. Wardle, M.E.I.C., **The Big Bend Highway.** Open to ladies. Attendance, 55.

Nov. 10.—J. M. Campbell, A.M.E.I.C., **Economics Old and New.** Attendance, 29.

Nov. 24.—Motion picture of the various works and jobs accomplished by Vickers-Armstrong Ltd., England. Attendance, 45.

Dec. 15.—D. H. Elton, K.C., **Democracy at the Cross Roads.** Ladies night. Attendance, 40.

At December 31st, 1934, the membership of the Branch was as follows:—

	Resident	Non-Resident	Total
Members	4	..	4
Associate Members	17	4	21
Juniors	1	1	2
Students	4	7	11
Affiliates	18	..	18
	44	12	56

Financial Statement
(As at December 31st, 1934)

Revenue		
Bank balance as at December 31st, 1933	$ 23.08	
Rebates received from Headquarters, January to September incl.	52.50	
Branch News revenue	.....	
Branch Affiliates fees and Journal subscriptions	38.15	
Bank interest	.60	
Refund for dinner, R. C. Davis	.75	
Rent from motion picture projector	15.00	
Total revenue		$130.08
Expenditure		
Printing and stationery	$ 21.28	
Meeting expenses—music, films, dinners, etc.	60.75	
Headquarters—Branch Affiliates, Journal subscriptions	4.00	
Orchestra, etc.	15.00	
Postage, exchange, etc.	2.90	
Total expenditures		$103.93
Bank balance as at December 31st, 1934		$ 26.15
Assets		
Bank balance as at December 31st, 1934	$ 26.15	
Holmes projector, value $360.25, less 40% depreciation	216.15	
Rebates due from Headquarters, October to December incl.	8.70	
Total assets		$251.00
Liabilities		
Robins Printing Company	$ 3.18	
Miss G. E. Doe	1.00	
Total liabilities		$ 4.18

We have examined the books, vouchers, papers and the foregoing statement prepared by the Secretary-Treasurer and find the same to be a true and correct account of the standing of the Branch.

G. S. Brown, A.M.E.I.C. }
P. M. Sauder, M.E.I.C. } Auditors.

Respectfully submitted,
C. S. Donaldson, A.M.E.I.C., *Chairman.*
E. A. Lawrence, S.E.I.C., *Secretary-Treasurer.*

London Branch

The President and Council:—

During the year 1934, the following meetings were held:—

1934

Jan. 17.—Annual meeting with General Armstrong, Commanding Officer M.D. No. 1, as guest speaker. Attendance, 40.

Feb. 21.—Illustrated lecture by Mr. G. A. Woonton of the University of Western Ontario on the **Oscillograph and its Uses.** Held at U. of W.O. Attendance, 60.

Mar. 21.—Address by Mr. Chas. Hunter on **Ionization and its Relation to the Modern Subject of Air Conditioning.** Attendance, 36.

April 25.—A social evening by members at the home of E. V. Buchanan, M.E.I.C. The guests were entertained at bridge. Refreshments served by the host.

Oct. 31.—Address by Mr. Wm. Duffield, president of the City Gas Co. of London, on **The Dawn Gas Fields.** Attendance, 29.

1935

Jan. 4.—Considered as regular December meeting, in which the Vickers-Armstrong films were shown at the London Technical School. Estimated attendance, 800.

Average attendance of all meetings, 160.

In addition to the above, six Executive meetings were held throughout the year with an average attendance of eight.

Financial Statement
(For year ending December 31st, 1934)

Receipts			
Cash on hand, January 1st, 1934		$ 3.10	
Bank balance		152.69	
Affiliate fees		5.00	
Branch News—Secretary		5.75	
Rebates from Headquarters	$85.50		
Less half Headquarters loan paid	25.00		
		60.50	
Rebate due from Headquarters, December 31st, 1934		8.70	
			$235.74
Expenditures			
Annual Dinner expenses		$ 32.03	
Stenographer for 1933		5.00	
Journal subscriptions for Affiliates		4.00	
Printing		20.65	
Flowers—re Munroe		4.00	
Elevator service		1.50	
Hall rental and film operator for Vickers-Armstrong pictures		10.00	
Secretary's expenses—Stamps, etc.		15.47	
		$ 92.65	
Cash on hand, December 31st, 1934		3.10	
Bank balance		131.29	
Rebate due from Headquarters		8.70	
			$235.74

V. A. McKillop, A.M.E.I.C. }
D. M. Bright, A.M.E.I.C. } Auditors.

Respectfully submitted,
Frank C. Ball, A.M.E.I.C., *Chairman.*
H. A. McKay, A.M.E.I.C., *Secretary-Treasurer.*

Moncton Branch

The President and Council:—

On behalf of the Executive committee we beg to submit the fifteenth annual report of Moncton Branch.

The Executive committee held four meetings. Ten meetings of the Branch were held, at which addresses were given and business transacted as follows:—

1934

Jan. 29.—A meeting was held in the City Hall for the purpose of discussing proposed amendments to Institute By-laws and making recommendations to the forthcoming annual meeting.

Feb. 26.—A meeting was held in the City Hall. Herbert Tucker, M.A., Ed.M., M.R.E., Ph.D., Professor of Economics, Mount Allison University, Sackville, delivered an address on **The Proposed Central Bank for Canada.**

Mar. 14.—A meeting was held in the City Hall. W. B. Burchall, advertising manager, Canadian Airways, Ltd., Montreal, delivered an illustrated address on **The Contribution of the Aeroplane to Canadian Industrial Development.**

Mar. 20.—A combined meeting of Moncton Branch and the Engineering Society of Mount Allison was held in the Eurhetorian Hall of the University of Sackville. H. J. Crudge, A.M.E.I.C., building engineer, Canadian National Railways, Moncton, read a paper on **Engineering Estimates.**

April 10.—A combined meeting of Moncton Branch and the Engineering Society of Mount Allison was held in the Centennial Hall of the University at Sackville. T. H. Dickson, B.Sc., A.M.E.I.C., delivered an illustrated address on **Streamlined Vehicles.**

April 17.—A meeting was held in the City Hall. H. E. Bigelow, Ph.D., F.R.S.C., Professor of Chemistry, Mount Allison University, Sackville, delivered an address on **Chemistry in Industry.**

At this meeting nominations were made for branch officers for the year 1934-35.

May 31.—The annual meeting was held, at which the annual report and financial statement was presented, the report of the scrutineers received and the branch officers for 1934-35 announced.

Oct. 5.—A meeting was held in the City Hall for the purpose of discussing with the branch Councillor, H. J. Crudge, A.M.E.I.C., certain matters to be dealt with at the next meeting of Council.

Oct. 16.—A meeting was held in the City Hall. Six reels of motion pictures were shown, descriptive of ship building operations and aeroplane trials at the works of the Vickers-Armstrong Company, England.

Dec. 10.—A supper meeting was held in the Y.M.C.A. in honour of President F. P. Shearwood, M.E.I.C. Mr. Shearwood addressed the meeting on Institute affairs and also gave an illustrated address on **Some Problems of Bridge Erection.**

Membership

Our membership at present consists of forty-seven members as follows:—

	Resident	Non-Resident
Members	5	1
Associate Members	19	6
Juniors	2	2
Students	4	6
Affiliates	2	..
	32	15

It is with deep regret that we record the passing of Michael Joseph Murphy, A.M.E.I.C., a former chairman of the Branch, whose death occurred on December 30th.

Financial Statement
(Year ending December 31st, 1934)

Receipts

Balance in bank, January 1st, 1934	$232.82	
Cash on hand, January 1st, 1934	2.89	
Rebates on dues	67.50	
Affiliate dues	10.00	
Branch News	3.38	
Tickets sold for supper meetings	8.50	
Bank interest	5.44	
Rebates due from Headquarters	10.50	
		$341.03

Expenditures

Expenses of meetings	$ 28.20	
Printing and advertising	22.03	
Postage	5.68	
Telegrams and telephones	3.22	
Payment on account of $50 loan advanced by Headquarters to the Branch, at the time of formation.	25.00	
Honorarium to Secretary	25.00	
Miscellaneous	42.59	
Balance in bank	175.30	
Cash on hand	3.51	
Rebates due from Headquarters	10.50	
		$341.03

Assets

Balloptican lantern	$ 30.00	
Attache case	5.00	
Cash in bank	175.30	
Cash on hand	3.51	
Rebates due from Headquarters	10.50	
		$224.31

Liabilities
None

Audited and found correct,
James Pullar, A.M.E.I.C. }
H. B. Titus, A.M.E.I.C. } Auditors.

Respectfully submitted,
J. G. MacKinnon, A.M.E.I.C., *Chairman.*
V. C. Blackett, A.M.E.I.C., *Secretary-Treasurer.*

Montreal Branch

The President and Council:—

We have the privilege of submitting the following report of the activities of the Montreal Branch during the past year.

There are a certain number of activities which from year to year come under the responsibility of the Executive committee. These are usually considered by the membership as a matter of course, though they represent the bulk of the business of the Branch. This routine work includes various items such as looking after our weekly meetings and meetings of the Executive committee; the organization of many sub-committees; keeping contact with the Council of The Institute; and helping Headquarters as much as possible in collecting the dues from the members of the Montreal Branch, and generally keeping the Branch alive.

In regard to this general work we feel that we can report that results this year have been up to the high standard established by past Executive committees.

Our financial statement given below shows that notwithstanding increased service to our membership and the expense of holding the Annual General Meeting in Montreal, our finances are in good shape. We have managed to keep our surplus at practically the same level it has been in recent years. A greater number of technical meetings have involved higher expenses in the sending out of notices and in the courtesies extended to our speakers. If it were not for the loss sustained by the Annual Meeting we would have been able to show a substantial surplus on the year's operation. In view of these facts we feel satisfied with the results shown.

Financial Statement
Revenue

Ordinary:			
Rebates from Headquarters	$1,593.60		
Affiliate dues	43.00		
Interest	7.53		
		$1,644.13	
Surplus from 1933		1,220.48	
Revenue from A.G. and P.M.		1,859.59	
Dinners to speakers		50.80	
			$4,775.00

Disbursements

Post cards notices	$ 669.11		
Stationery and stamps	25.35		
Secretary's honorarium	300.00		
Stenographic service	120.00		
Telephone and telegraph	60.95		
Lantern operator and slides	103.00		
Subscriptions to Journal	18.00		
Thursday refreshments	76.80		
Speakers' travelling and dinners	109.24		
Economics course	21.19		
Miscellaneous	27.25		
		$1,530.89	
Annual General and Professional Meeting		2,106.11	
Cash on hand		1,138.00	
			$4,775.00

We have also carried out the excellent work promoted by our predecessors in regard to the help extended to our unemployed. During December and January 1933 and 1934 we raised by subscriptions from the members $872.50. During November and December 1934 we were forced to make an additional appeal when an amount of $710.00 was subscribed. While this latter amount was a little lower nevertheless it is very encouraging to receive such a generous response under present financial conditions. Our successors will have a difficult task concerning unemployment, but we trust that with the help of the membership they will be able to carry on for the benefit of those of us who are in dire straits. The financial statement for the year ending December 31st, 1934, for the Unemployment Relief Fund is as follows:

Subscriptions	$1,582.50	
Bank interest	11.20	
Repaid to fund	43.83	
		$1,637.53
Disbursements	$1,208.60	
Deficit—1933	54.97	
Balance on hand	373.96	
		$1,637.53

We have on two occasions this year interested ourselves in the affairs of our city. A special general meeting was held on March 15th at which it was decided to join the "Montreal Board of Trade" and the "Chambre de Commerce" in requesting the Prime Minister of this province to take steps towards the appointment of a commission which would for a certain period be entrusted with the government of the city of Montreal. Later on during the year, a committee was appointed to collaborate with the sanitary engineer of the city of Montreal in the preparation of by-laws to regulate certain phases of building construction.

The Branch had the privilege of being host to the Annual General Meeting of The Institute in February. The Annual Report of The Institute will show that the attendance at that meeting was more than satisfactory. We hope that we have succeeded in upholding the reputation of this city, by our hospitality and attention to out-of-town members.

On two occasions we had the honour of officially receiving the Presidents of The Institute. In January Dr. O. O. Lefebvre, M.E.I.C., addressed the Branch, while in October we had an address by Mr. F. P. Shearwood, M.E.I.C.

Besides taking care of the normal business of the Branch, we believe that it is the duty of each successive Executive committee to promote some new activity or at least to improve very definitely on some part of the general routine work. This has been achieved this year to a great extent through the excellent work of our Papers and Meetings committee under the most able chairmanship of J. G. Hall, M.E.I.C., as shown by many innovations which undoubtedly you have already noticed. We are therefore pleased to incorporate in our report the following remarks which were presented by Mr. Hall in his report to the Executive committee:—

Senior Section

Meetings held during spring session were as follows. These meetings had been arranged for by the previous committee.

Meetings held Spring Session 1934:—

Jan. 4.—Branch Annual Meeting. Official visit of Dr. O. O. Lefebvre, M.E.I.C.

Jan. 11.—**Historical Aspects of Radio Development** by J. H. Thompson, A.M.E.I.C.

Jan. 18.—**Geology and Civil Engineering** by R. F. Legget, A.M.E.I.C.

Jan. 25.—**Increasing Continuity of Service** by Mr. F. A. Hamilton, Jr.
Feb. 1.—**European Construction** by Mr. Jacques Rabut.
Feb. 8.—Annual Meeting of E.I.C. held in Montreal.
Feb. 15.—**Central Heating** by W. G. Chace, M.E.I.C.
Feb. 22.—**Development in "Long Distance"** by Mr. A. B. Clark.
Mar. 1.—**The Contribution of the Aeroplane to Canadian Industrial Development** by Mr. W. B. Burchall.
Mar. 8.—**Common Frequency Radio: Broadcasting** by Messrs. J. L. Clarke, M.E.I.C., and C. B. Fisher.
Mar. 15.—Student Night.
Mar. 22.—**The Operation of an Hydro-Electric System** by Messrs. C. R. Reid, W. R. Way, A.M.E.I.C., and E. W. Knapp, A.M.E.I.C.
Mar. 29.—**The Automotive Diesel Engine** by J. L. Busfield, M.E.I.C.
April 5.—**Main Cables and Suspenders for Suspension Bridges** by Mr. C. D. Meals.
April 12.—**Some Aspects of Railway Maintenance** by Mr. W. O. Cardworth.
April 26.—**Co-operation of the Engineer and Architect in Town Planning** by Mr. Jacques Gréber.
May 3.—**Empire of Steel.** Movie.

Meetings held from July to December 1934:—

July 26.—**The British Grid System.** Movie.
Sept. 6.—**Prestressing Suspension Bridge Cable Strands.** Actual operation by courtesy of Dominion Bridge Co.
Oct. 4.—**Construction of S.S. Strathnaver and Steel Making at Sheffield.** Movie.
Oct. 11.—**Some Problems Facing the Institute** by F. P. Shearwood, M.E.I.C.
Oct. 18.—**Construction Equipment of the Hoist Operated Type** by C. C. Langstroth, A.M.E.I.C.
Oct. 24.—**Grounds and Grounding** by S. H. Cunha, A.M.E.I.C.
Oct. 25.—**City Noises and the Need for Their Control** by Prof. H. E. Reilley.
Nov. 1.—**Modern Sewage Treatment Practice** by Mr. E. B. Besselievre.
Nov. 8.—**Un Nouveau Gazogène pour l'Industrie Canadienne** by Paul Vincent, S.E.I.C.
A Small Power Plant for a Game Lodge by Mr. E. S. Cooper.
Nov. 15.—**Economics of the Durable Goods Industry** by Dr. D. M. Marvin.
Nov. 22.—**Application Engineering on Motors and Control** by Mr. W. C. Raube.
Nov. 23.—Discussion of Mr. Raube's Paper.
Nov. 29.—**X-Ray in Medical Science** by Dr. W. L. Ritchie.
Dec. 6.—**Design and Application of Gears** by Mr. W. P. Muir.
Dec. 10.—Further development of above subject by Mr. W. P. Muir.
Dec. 12.—**Electron Tubes in Industry** by Mr. D. L. West.
Dec. 13.—**Relationship Between Architecture and Engineering** by J. M. Oxley, M.E.I.C.

The programme for the Spring Session of 1935 has already been published and additions may be made later.

During the term from July to December, excluding student night, the total attendance was 1,747 with 16 meetings, being an average per meeting of 109 or 134 per week. This corresponds to a total attendance of 1,155 with 11 meetings during the similar period of 1933.

It will be noted that four meetings were held on evenings other than Thursday. These were to give an opportunity for a more complete and informal discussion of the subjects in question by members of the sections more particularly interested.

A series of special lectures by Dr. D. M. Marvin on "Current Economic Topics" is being held. These are for members of The Institute only, and are being attended by twenty-one members. These lectures are self-supporting, a fee being charged to cover expenses.

An interesting feature in connection with the activities of the Junior Section was the number of papers presented in French.

Based on experience this past year your committee begs to submit the following suggestions for the consideration of the incoming Papers and Meetings committee:—

1. That the chairman and vice-chairman of each section add to their numbers and meet to discuss their programme for the year, apart from the general committee meetings.
   This should—
   (*a*) Increase the scope of subjects obtained.
   (*b*) Save considerable time at the general committee meetings.
   (*c*) Increase the number of members actively interested in Branch activities.
2. That the policy of having Section Meetings on evenings other than Thursdays be developed to include possibly all sections. It is believed that in this way the members of the Branch will be encouraged to make greater use of the facilities available and take a greater interest in the work of The Institute.
3. That consideration be given to a more standardized form both for invitations to present, and tendering thanks, for papers presented.

Our members will agree that a decided step forward has been taken this year in our technical meetings which represent, after all, the most important part of the service which we can render to our members.

Junior Section

The Junior Section of the Branch have just completed their second complete year of activities and have held fourteen meetings in all. On each evening two papers were usually given, a number of them being in French. The majority of the papers were given by the Junior members and we feel that this is a very excellent part of the Branch work, as it is serving to develop public speaking in the Branch and overcoming the engineer's usual hesitation at standing on his feet in public.

Membership

Fortunately, notwithstanding adverse conditions, our membership was maintained, so that at present it includes a total of 1,127 as against 1,125 last year. This includes 130 who are on the non-active list, but there were approximately the same number last year.

During the past year we lost a large number of members through death, several of them being well known in public life as well as being active in The Institute. You will note that two of them were Charter Members. It is with deep regret that we record their names as follows:—

Members:

Major General Charles Johnstone Armstrong, C.B., C.M.G., V.D.
Archibald Abercromby Bowman.
Pierre Michel Helbronner.
Paul Albert Nicholas Seurot.
Sven Svenningson.
William Henry Wardwell.

Associate Members:

Harry Brooke Aylmer (1887).
Harry B. Pope.
S. S. Shector.
J. Emile Vanier (1887).

Judging by the interest that has been shown at the meetings and in the affairs of the Branch in general, we feel sure that 1935 will be a successful year.

Respectfully submitted,

A. Frigon, M.E.I.C., *Chairman.*
C. K. McLeod, A.M.E.I.C., *Secretary-Treasurer.*

Niagara Peninsula Branch

The President and Council:—

The Executive committee of the Niagara Peninsula Branch presents herein the report for the year 1934.

The Executive held four regular meetings and one electoral meeting with an average attendance of ten.

The meetings are listed as follows:—

1934

Jan. 19.—Dinner meeting, Fox Head Inn, Niagara Falls; speaker, A. W. McQueen, A.M.E.I.C., of H. G. Acres Co.; topic, **Engineering Investigation in India.**
Feb. 15.—Joint dinner meeting with A.I.E.E. at Niagara Falls, N.Y.; speakers, W. H. Rodgers of Westinghouse Co. and R. H. Rodgers of General Electric Co.; topic, **Recent Developments in Electrical Research.**
April 11.—Dinner meeting, Lincoln Hotel, St. Catharines; speaker, Mr. F. Nagler, Canadian Allis Chalmers Co., Toronto; topic, **What Mechanical Tests are Worth While.**
May 17.—Annual meeting, Fox Head Inn, Niagara Falls; Mr. F. P. Shearwood, M.E.I.C., President of the E.I.C., was present and gave a short talk on Institute affairs; Col. Morrow, Fort Niagara, Youngstown, N.Y., gave a talk on his experiences in Siberia.
Sept. 28.—Inspection trip at Old Fort Niagara, Youngstown, N.Y., followed by a dinner at the Old Fort Inn and talk by Mr. Claude Hultzen describing the restoration work.
Oct. 19.—Inspection trip Yale & Towne Manufacturing Co., St. Catharines; Dinner at Lincoln Hotel followed by talk by Mr. Ellis Jones, manager of Yale & Towne Co., on the **History of Locks.**

Membership

Members	19
Associate Members	52
Juniors	2
Students	7
Affiliates	15
Non-Active	16
	111

The Branch mourns the loss of one of its most devoted members, Alex. Milne, A.M.E.I.C., of St. Catharines.

Financial Statement
(January 1st to December 31st, 1934)

Receipts

Bank balance, January 1st, 1934	$242.51	
Rebates	172.35	
Branch News	1.25	
Meetings	65.25	
Bank interest	5.36	
		$486.72

Expenditures

Meetings	$106.49	
Printing and postage	23.48	
Secretary's honorarium	100.00	
Flowers	8.00	
Present	3.00	
Affiliate dues	30.00	
Bank balance, December 31st, 1934	215.75	
		$486.72

Respectfully submitted,
W. R. Manock, A.M.E.I.C., *Chairman.*
P. A. Dewey, A.M.E.I.C., *Secretary-Treasurer.*

Ottawa Branch

The President and Council:—

On behalf of the Managing committee of the Ottawa Branch we beg to submit the following report for the calendar year 1934.

During the year the Managing committee held eight meetings for the transaction of general business. In addition the Branch held eighteen meetings. These meetings were well attended and excellent addresses were enjoyed at the Branch meetings.

It is with deep regret that we report the loss through death of two members—S. Bray, M.E.I.C., and W. C. Treanor, A.M.E.I.C.

As in previous years the Branch donated two sets of draughting instruments to the Ottawa Technical School for presentation as prizes for proficiency in draughting, and a copy of "Standard Handbook for Electrical Engineers" to the Hull Technical School for presentation as a prize to a student in the Department of Electricity.

Proceedings and Publicity

During the year twelve luncheon meetings and five evening meetings were held, and a visit made to the studio and transmitting station of the Canadian Radio Broadcasting Commission at Ottawa. The dates of the meetings and speakers are as follows:—

1934

Jan. 11.—Luncheon address, Major D. L. McKeand, **Eastern Arctic Patrol 1933.** Attendance, 88.

Jan. 11.—Annual Meeting of Branch, Standish Hall. Attendance, 80.

Jan. 25.—Luncheon address, Professor Theo. J. Lafreniere, M.E.I.C., **Public Health in Quebec.** Attendance, 60.

Feb. 8.—Annual Meeting of Institute, Montreal.

Feb. 22.—Luncheon address, Dr. D. F. Kidd, **The Great Bear Lake District.** Attendance, 93.

Mar. 8.—Luncheon address, Col. E. J. C. Schmidlin, M.E.I.C., **North-west State Railways of India.** Attendance, 85.

Mar. 22.—Luncheon address, W. P. Dobson, M.E.I.C., **The Hydro-Electric Power Commission Laboratories.** Attendance, 75.

April 4.—Evening meeting, Jackson Building, discussion on proposed amendments to By-laws. Attendance, 20.

April 20.—Luncheon address, C. W. Wright, **Canada at the World's Fair.** Attendance, 45.

May 3.—Luncheon address, J. Clark Reilly, **What the Construction Industry Means to Canada.** Attendance, 55.

May 26.—Visit, Studios and Transmitting Station, Ottawa, of the Canadian Radio Broadcasting Commission. Attendance, 60.

June 15.—Evening meeting, National Research Laboratories, Mr. Messter and Mr. Heinz Grüner, demonstration lecture on **Photogrammetic Apparatus.** Attendance, 50.

Oct. 4.—Luncheon address, J. Grove Smith, **Re-housing a Nation.** Attendance, 71.

Oct. 18.—Luncheon address, Dr. J. J. Green, **Streamlining.** Attendance, 65.

Oct. 25.—Evening meeting, Vickers Armstrong films. Attendance, 120.

Nov. 8.—Luncheon address, Martin J. Berlyn, A.M.E.I.C., **Transmission Gearing.** Attendance, 62.

Nov. 22.—Evening meeting, H. E. McKeen, **Placing Concrete by Pipe Line and Vibration.** Attendance, 40.

Dec. 6.—Luncheon address, F. E. Lathe, **Refractories in Industry.** Attendance, 70.

Dec. 20.—Luncheon address, T. A. McElhanney, A.M.E.I.C., **Engineering and Economic Aspects of Forest Products Industries.** Attendance, 61.

Membership

Owing to deaths, resignations, and members removed from the roll, the membership shows a decrease of 21 during the year.

The following table shows in detail the comparative figures for the years 1933 and 1934:—

	1933	*1934*
Honorary Members	1	1
Members	80	76
Associate Members	173	166
Affiliates of Institute	3	3
Juniors	16	15
Students	33	34
Branch Affiliates	36	31
Resident Members	342	326
District Members	63	59
	405	385

Finances

The attached financial statements show that the Branch had a surplus of $83.70 in revenue over expenditure at the end of the year. The year closed with a balance of $652.49 in the bank, $17.05 cash on hand, and $1,000 in Government Bonds; a total of $1,669.54. In addition the Branch has assets of $42.90 in rebates due from the Main Institute; and $21 in equipment, etc., making a total of $1733.44.

Committee on Unemployment

No new relief projects were started in the Ottawa district and therefore no new appointments were available on the supervisory staff. Two vacancies however were filled by engineers recommended by The Institute.

At the present time the Committee has no report of any members in urgent need of relief or employment though many members are out of employment.

The Committee has kept in touch with the administration of the Relief Projects of the Department of National Defence and has to thank the departmental officers for their co-operation.

Aeronautical Section

This section of the Ottawa Branch has a membership of 95. Eight evening meetings were held, when technical papers dealing with aeronautical or related subjects were read and discussions held.

Financial Statement
(For the year ending December 31st, 1934)

Receipts

Balance in bank, January 1st, 1934	$579.87	
Cash on hand, January 1st, 1934	5.97	
Interest on Dominion of Canada Bonds	52.50	
Bank interest	11.30	
Rebates from Main Institute, Oct.-Dec. 1933	51.60	
" " " " Jan.-Apr. 1934	394.60	
" " " " May-Sept. 1934	39.60	
" " " " Branch News, July-Dec. 1933	6.62	
Branch Affiliate fees	84.00	
Proceeds from sale of luncheon tickets	358.00	
Casual	4.50	
		$1,588.56

Expenditures

Standish Hall—Annual Meeting, 1934	$ 29.05	
Chateau Laurier luncheons	584.50	
Grant to Aeronautical Section	20.00	
Subscriptions to Engineering Institute Journal	6.00	
Scrims, florist	10.00	
Printing	185.69	
Sundries, gratuities, prizes, etc.	60.40	
Petty cash, postage, telegrams, etc.	23.38	
Balance in bank, December 31st, 1934	652.49	
Cash on hand, December 31st, 1934	17.05	
		$1,588.56

Assets

Stationery and equipment	$ 20.00	
Library	1.00	
Rebates due from Main Institute account 1934 fees	42.90	
Dominion Government Bonds	1,000.00	
Balance in bank	652.49	
Cash on hand	17.05	
		$1,733.44

Liabilities

Surplus		$1,733.44

Respectfully submitted,
Alan K. Hay, A.M.E.I.C., *Chairman.*
F. C. C. Lynch, A.M.E.I.C., *Secretary-Treasurer.*

Peterborough Branch

The President and Council:—

On behalf of the Executive committee of the Peterborough Branch of The Engineering Institute of Canada, we have the honour to submit the following report covering the activities of the Branch during the year 1934:—

1934

Jan. 11.—**What Mechanical Tests are Worth While** by Mr. F. A. Nagler, M.A.S.M.E., chief engineer, Canadian Allis Chalmers Co., Ltd., Toronto.

Feb. 8.—**Industrial Applications of Photo Electric Relays** by Mr. A. G. Turnbull, Canadian General Electric Co. Ltd., Toronto.
Mar. 8.—**The Mining Industry of Northern Ontario** by Mr. G. Klein, Canadian General Electric Co. Ltd., New Liskeard, Ont.
April 12.—**The Contribution of the Aeroplane to Canadian Industrial Development** by Mr. W. B. Burchall, advertising publicity manager, Canadian Airways Ltd.
May 10.—Annual Meeting, Reports and Election of Officers.
June 2.—Visit to Plant of General Motors of Canada, Ltd., Oshawa, Ont.
Sept. 8.—Annual Outing, Rotary Camp, Clear Lake.
Oct. 11.—**Experiences of an Engineer in Soviet Russia** by Mr. T. G. Fechnay, The Pratt & Whitney Co. of Canada, Ltd.
Nov. 8.—Showing of Vickers Armstrong films at Capitol Theatre, Peterborough.
Nov. 20.—Annual Dinner, Empress Hotel, Peterborough. Speakers: Mr. F. P. Shearwood, M.E.I.C., President E.I.C., Mr. C. W. Woodside, University of Toronto.
Dec. 13.—**The Stresses in Wire Rope and in Fittings for Same** by Mr. C. D. Meals, The B. Greening Wire Co. Ltd., Hamilton, Ont.

The average attendance at the ordinary Branch meetings was 40.

The visit to the Oshawa Plant of the General Motors was enjoyed by approximately 80 of the members and their friends, and the showing of the Vickers-Armstrong films was witnessed by over 300 people.

Number of Executive meetings held during the year was six.

Special sub-committees were as follows:—

Meetings and Papers Committee	B. Ottewell, A.M.E.I.C.
	A. B. Gates, A.M.E.I.C.
	E. J. Davies, Jr.E.I.C.
Branch News Editor	E. J. Davies, Jr.E.I.C.
Membership Committee	B. L. Barns, A.M.E.I.C.
	V. R. Currie, A.M.E.I.C.
	D. J. Emery, S.E.I.C.
Unemployment Committee	W. M. Cruthers, A.M.E.I.C.
Social and Entertainment Committee	R. L. Dobbin, M.E.I.C.
	A. L. Dickieson, A.M.E.I.C.
	A. L. Killaly, A.M.E.I.C.
By-laws and Developments	R. L. Dobbin, M.E.I.C.
	E. R. Shirley, M.E.I.C.
	J. Barnes, A.M.E.I.C.
Auditor	E. R. Shirley, M.E.I.C.

MEMBERSHIP

Jan. 1st,	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*
Members	20	18	15	13	13	11
Associate Members	31	30	34	36	35	30
Juniors	20	20	19	13	11	12
Students	30	23	19	16	16	18
Branch Affiliates	25	17	15	17	14	13
	126	108	102	95	89	84

FINANCIAL REPORT

Receipts		
Balance, January 16th, 1934	$ 52.86	
Affiliate fees	51.85	
Rebates from Headquarters	84.95	
Receipts from annual banquet	65.50	
Interest	.72	
		$255.88
Expenditures		
Printing	$ 50.14	
Affiliate fees to Headquarters	26.30	
Flowers	13.00	
Rent	16.00	
Speakers expenses	7.30	
Obituary photo	.64	
Stamps, etc	3.53	
Annual banquet	64.95	
Lantern insurance	4.80	
Capitol Theatre meeting	3.35	
Balance, December 22nd, 1934	65.87	
		$255.88

Respectfully submitted,

J. W. PIERCE, M.E.I.C., *Chairman.*
H. R. SILLS, Jr.E.I.C., *Secretary.*

Quebec Branch

The President and Council:—

On behalf of the Executive committee of the Quebec Branch, we have the honour to submit the following report covering the activities of the Branch during the year 1934.

MEMBERSHIP

January 1st, 1935	*Resident*	*Non-Resident*	*Total*
Honorary Member (Branch)	1	..	1
Members	14	..	14
Associate Members	63	9	72
Juniors	2	..	2
Students	9	2	11
Affiliates	1	..	1
	90	11	101

It is with the deepest regret that we report the death of E. A. Hoare, M.E.I.C., who died in Quebec on November 23rd, 1934; Mr. Hoare was one of the founders of our Branch and had been a member of The Institute since 1887, the year it was incorporated as The Canadian Society of Civil Engineers.

MEETINGS

During the year 1934, the Branch Executive committee held six regular meetings with an average attendance of seven.

In addition the Branch held ten general meetings as follows:—

1934

Jan. 15.—Luncheon meeting at Chateau Frontenac. Speaker: Lt.-Col. J. B. Dunbar, A.M.E.I.C., District Engineer Officer, Military District No. 5, Quebec. Subject: **Road Making by Hand Methods, Using an Asphaltic Emulsion.**
Feb. 12.—Evening meeting at Palais Montcalm. Speakers and subjects: Marc Boyer, A.M.E.I.C., Bureau of Mines, Quebec: **Valuation of Non-Metallic Mineral Deposits;** Maurice Royer, C.E. of Ricard & Royer, Quebec: **Météorologie Moderne;** E. D. Gray-Donald, A.M.E.I.C., Quebec Power Company, Quebec: **Operation of a Hydro-Electric Power System.**
Feb. 23.—Evening meeting at Palais Montcalm. By courtesy of the Otis-Fensom Elevator Company, two films were shown to our members: one on **The Construction of the Empire State Building,** the other on **The Construction of the George Washington Bridge.**
Mar. 12.—Evening meeting at Palais Montcalm. Speaker: H. P. Burrell, Vice-President and General Manager of Franki Compressed Pile Co. of Canada Ltd., Montreal. Subject: **The Evolution of the Cast-in-Place Concrete Pile.**
April 6.—Luncheon meeting at Chateau Frontenac. F. P. Shearwood, M.E.I.C., President of The Engineering Institute of Canada, visiting our Branch addressed the members on Institute matters.
April 17.—Evening meeting at Palais Montcalm. Speaker: J. Antonio Lalonde, A.M.E.I.C., chief engineer, A. Janin & Company Ltd., Montreal. Subject: **La sous-structure et les approches du pont du lac St-Louis.**
May 14.—Annual Meeting and election of officers.
Aug. 15.—First visit to the Isle d'Orleans Bridge.
Oct. 20.—Second visit to the Isle d'Orleans Bridge.
Oct. 22.—Evening meeting at Palais Montcalm to see the display of three films loaned to The Institute by the Vickers-Armstrong Limited, London, England.

The average attendance at the above meetings was 42.

FINANCIAL STATEMENT

Receipts		
Bank balance, January 1st, 1934	$ 42.25	
Bank interest	.64	
Rebates on fees, May 1934	155.10	
Rebates on fees, October 1934	14.85	
Rebates on fees, December 1934	19.65	
		$232.49
Expenditures		
Meetings	$ 26.55	
Stamps, postcards, etc	22.27	
Printing	30.14	
Floral tribute (E. A. Hoare)	10.00	
Honorarium to Secretary	100.00	
	$188.96	
Bank balance, December 31st, 1934	43.53	
		$232.49

Respectfully submitted,

H. CIMON, M.E.I.C., *Chairman.*
JULES JOYAL, A.M.E.I.C., *Secretary-Treasurer.*

Saguenay Branch

The President and Council:—

On behalf of the Executive committee of the Saguenay Branch of The Engineering Institute of Canada, we beg to submit the following report for the calendar year 1934.

MEMBERSHIP

Our membership this year shows a gain of two. This does not include four applications which are now in, two of which are for admission as Associates and two for transfer from the grade of Student to that of Associate.

The following table gives a comparison of our membership as of December 31st for the past five years.

	1930	*1931*	*1932*	*1933*	*1934*
Members	6	5	4	3	3
Associate Members	25	19	16	18	19
Junior Members	7	4	4	3	3
Student Members	11	7	5	5	6
Affiliates	..	..	1	..	..
	49	35	30	29	31

Branch Meetings

During the year Branch meetings were held as follows:—

1934

Jan. 31.—The meeting was addressed by Mr. N. F. Russell on **Applications of Aluminum with special reference to the Mining and Transportation Fields.** On this date we experienced one of the worst storms of the winter, which closed all the roads, so that only twenty-five members and guests were present—all from Arvida.

May 9.—P. L. Pratley, M.E.I.C., addressed a meeting, his subject being **Recent Bridge Construction in the Province of Quebec.** Fifty members and guests were present.

Aug. 2.—F. L. Lawton, A.M.E.I.C., read a paper before an attendance of thirty-five on the subject of **Heat Economy and Comfort in the Home as Influenced by Heating Methods and Building Construction.** This paper appeared in the November issue of the E.I.C. Journal.

Aug. 30.—The Annual Meeting preceded by a dinner was held at The Staff Club at Arvida, seventeen members being present. The results of the annual election of officers were announced and the latter part of this meeting was spent in listening to a paper given by M. G. Saunders, A.M.E.I.C., on the subject of **The Production and Explosibility of Gases Generated in Electric Boilers.**

Oct. 22.—A. Lariviere, M.E.I.C., presented a paper before a meeting of forty-five members and guests on **The Fundamental Principles of Radio Electricity.**

Financial Statement

Receipts

Balance on hand, December 31st, 1933	$128.21	
Rebates from Headquarters	60.45	
Branch News	3.12	
		$191.78

Disbursements

Exchange	$ .55	
Lantern rental	4.00	
Postage	6.86	
Meeting expenses	27.15	
	$ 38.56	
Balance on hand	153.22	
		$191.78

Respectfully submitted,

G. E. LaMothe, A.M.E.I.C., *Chairman.*
J. W. Ward, A.M.E.I.C., *Secretary-Treasurer.*

Saint John Branch

The President and Council:—

On behalf of the Executive committee of the Saint John Branch, we have the honour to submit the annual report for the calendar year ending December 31st, 1934.

Membership

	Resident	*Non-Resident*	*Total*
Members	10	5	15
Associate Members	21	11	32
Juniors	3	3	6
Students	13	20	33
Affiliates	1	1	2
	48	40	88

Meetings

Seven meetings of the Branch Executive committee were held during the year, also nine Branch meetings as follows:—

1934

Jan. 25.—Joint dinner of The Institute and the Association of Professional Engineers of New Brunswick. Following the dinner Professor B. S. Kierstead of the University of New Brunswick addressed the Branch on **The Task of Economics.**

Mar. 13.—Mr. W. B. Burchall of the Canadian Airways gave an illustrated lecture on **The Contribution of the Aeroplane to Canadian Industrial Development.**

Mar. 27.—C. S. MacLean, A.M.E.I.C., spoke on **The Operation of the Lobnitz Rock Breaking Apparatus.**

April 12.—This meeting was called to give the members a chance to discuss the question of Re-organization.

May 8.—Annual dinner and meeting held at the Riverside Golf and Country Club. The present officers of the Branch were elected at this meeting.

Sept. 25.—**The Automotive Diesel Engine** by J. L. Busfield, M.E.I.C.

Oct. 18.—The Vickers-Armstrong films.

Nov. 20.—**Broadcasting Equipment and Methods** by J. G. Bishop, chief engineer of CHSJ. After the address the Branch visited the studio and broadcasting room of the above station.

Dec. 4.—Dinner tendered F. P. Shearwood, M.E.I.C., President of The Institute.

Financial Statement

Assets

Balance, December 31st, 1934	$294.09	
Headquarters rebates, October to December	11.85	
		$305.94

Liabilities

Nil.

Receipts

Balance, December 31st, 1933	$327.46	
Headquarters rebates, January to April	104.40	
" " May to September	8.55	
" " October to December	11.85	
		$452.26

Expenditures

Stationery, printing and postage	$ 67.57	
Branch meetings	47.75	
Lantern slides	6.00	
Honorarium to Secretary	25.00	
	$146.32	
Balance, December 31st, 1934	294.09	
Headquarters rebates, October to December	11.85	
		$452.26

Respectfully submitted,

E. J. Owens, A.M.E.I.C., *Chairman.*
F. A. Patriquen, Jr.E.I.C., *Secretary-Treasurer.*

St. Maurice Valley Branch

The President and Council:—

The St. Maurice Valley Branch submits its annual report for the year 1934.

The membership at the end of this year was as follows:—

Members	5
Associate Members	24
Juniors	8
Students	10
	47

During the present year, the activities of the Branch have not been very considerable, owing to the fact that the city of Trois-Rivières has celebrated the tercentenary of its foundation. Most of the engineers were on different committees in connection with this organization, and have devoted their time to contribute to the success of this celebration. However, the Branch was able to hold three meetings during the year.

Nevertheless, all the questions submitted by the Council of The Institute and by different branches have been studied, discussed and transacted.

As during the past, our Branch has followed with interest The Institute's deliberations and has devoted its full energy to all the matters tending to the protection and promotion of the interests of The Institute and its members.

The St. Maurice Valley Branch deeply regrets the death of two of its members: Messrs. J. A. Bernier, Manager of the City of Grand' Mère, and Frank Panneton, engineer for the City of Trois-Rivières, who were always devoted to The Engineering Institute and also to their engineering profession.

The financial standing of the Branch is very satisfactory, the cash on hand on December 31st being $89.61.

At its last general meeting held on December 22nd, 1934, the officers of the Branch for the year 1935 were elected.

Financial Statement

Receipts

Money in bank, January 1st, 1934	$ 37.81	
Rebates from Headquarters, 1934	64.80	
		$102.61

Expenditures

Sundry expenditures (stamps, funeral tributes)	$ 15.00	
Balance in bank, January 1st, 1935	87.61	
		$102.61

Respectfully submitted,

Bruno Grandmont, A.M.E.I.C., *Chairman.*
J. Albert Hamel, A.M.E.I.C., *Secretary-Treasurer.*

Saskatchewan Branch

The President and Council:—

On behalf of the Executive we submit the following report of the activities of the Saskatchewan Branch for the year 1934.

Membership

The membership of the Branch is as follows, being a decrease of eight from last year:—

	Resident	Non-Resident	Total
Members	4	7	11
Associate Members	27	23	50
Juniors	2	4	6
Students	6	10	16
Branch Affiliates	4	..	4
	43	44	87

Committees

The Executive committee was elected on March 16th, 1934, and held six meetings during the year.

The standing committees are:—

Papers and Library........S. R. Muirhead, A.M.E.I.C. (Convenor)
Nominating..............D. A. R. McCannel, M.E.I.C. (Convenor)
Unemployment...........H. R. MacKenzie, A.M.E.I.C. (Convenor)
Membership..............P. C. Perry, A.M.E.I.C. (Convenor)

Meetings

There were six regular meetings of the Branch, each being preceded by a dinner at which the average attendance was twenty-eight, a decrease of seven from last year. The general interest in the meetings has been fair. In addition a general meeting was held during the month of February with a programme suitable for "Ladies Night." The attendance at this meeting was good.

The programme for the year was as follows:—

1934

Jan. 19.—Address by F. C. Curtis, B.C.L., on **Disarmament.**

Mar. 16.—Seventeenth Annual Meeting. Address by S. E. Slipper on **Gas and Oil Possibilities of Saskatchewan.**

July 25.—Special meeting. Address by F. P. Shearwood, M.E.I.C., on **The Present Status of The Engineering Institute of Canada,** following which Mr. Shearwood gave a lantern slide lecture on **Bridge Construction.**

Oct. 19.—Moving pictures showing the construction of **The Big Bend Highway** in British Columbia.

Nov. 16.—Address by A. W. Ellson Fawkes, consulting engineer, on **The City Manager Form of Government.**

Dec. 21.—Address by M. J. Coldwell, Provincial Leader C.C.F., on **The World Outlook for 1935.**

Saskatoon Section

Immediately following the annual meeting a Saskatoon section was formed under the direction of a committee composed of:—

R. A. Spencer, A.M.E.I.C. (Convenor)
A. R. Greig, M.E.I.C.
C. C. Hay, A.M.E.I.C.
A. M. MacGillivray, A.M.E.I.C.

Prior to the midsummer season three meetings were held, the respective programmes being:—

The Douglas Theory by B. P. Scull and W. L. Foss.

Recent Advances in Science by Dr. T. Thorvaldson, Dr. T. A. Alty, Professor W. G. Worcester, C. B. Jackson, E. J. Durnin, Jr.E.I.C., and A. B. Olsen—(Half-hour talks).

The Wheat Situation by Mr. Wesson of the Saskatchewan Wheat Pool.

Two meetings were also held during the latter part of 1934:—

Oct. 22.—Moving pictures showing construction of **The Big Bend Highway in British Columbia.**

Nov. 16.—Vickers-Armstrong films depicting **Steel Making, Aviation and Ship Building.**

In addition to sponsoring the above meetings, the Committee has spent considerable time on a study of Institute affairs.

Finances

The present financial standing of the Branch is as follows:—

Receipts		
Bank balance, December 31st, 1933	$100.12	
Rebates from Headquarters	145.02	
Branch dues	10.00	
		$255.14
Expenditures		
Postage	$ 8.00	
Meetings (notices, printing, etc.)	86.31	
Secretarial (1932)	50.00	
Miscellaneous	21.80	
Bank balance, December 31st, 1934	89.03	
		$255.14

Respectfully submitted,

R. A. Spencer, A.M.E.I.C., *Chairman.*
Stewart Young, A.M.E.I.C., *Secretary-Treasurer.*

Sault Ste. Marie Branch

The President and Council:—

Ten dinner meetings were held during 1934, eight at the Windsor hotel and two at the Sault Country Club.

We were honoured with two visits of officers from Headquarters. The General Secretary, R. J. Durley, M.E.I.C., addressed a special meeting at the Sault Country Club on July 27th. On August 3rd President F. P. Shearwood, M.E.I.C., also visited us and gave an illustrated talk on "Bridge Erection" followed by a talk on Institute affairs.

The average attendance at dinners was 26 with an average meeting attendance of about 32.

The meetings and speakers were as follows:—

1934

Jan. 26.—**Theory and Application of Industrial Methods for the Measurement of Flow in Pipes** by O. Brauns, A.M.E.I.C.

Feb. 23.—**The History of Great Lakes Shipping from 1812** by Captain James McCannel, Master of the *Assiniboia.*

Mar. 28.—**The History of Paper Making** by F. A. Masse, Jr.E.I.C.

April 27.—**The Tidal Phenomenon** by H. F. Bennett, A.M.E.I.C.

May 25.—**The Value of Engineering and Superintending of Oxy-Acetylene Welding and Cutting** by D. S. Lloyd, A.M.E.I.C.

July 27.—Visit of the General Secretary, R. J. Durley, M.E.I.C.

Aug. 3.—Visit of the President, F. P. Shearwood, M.E.I.C.

Sept. 28.—Discussion of the President's address.

Dec. 5 (Postponed from Nov. 30).—**Reminiscences of Northern Ontario** by James S. Dobie, O.L.S., D.L.S., of Thessalon, Ont.

Dec. 19.—Films from Vickers-Armstrong. Annual Meeting.

We regret to report the loss of two of our members by death during the past year.

The membership at the close of the year stands as follows:—

	Resident	Non-Resident	Total
Regular:			
Members	9	11	20
Associate Members	12	26	38
Juniors	5	9	14
Students	..	17	17
Branch Affiliates	7	..	7
	33	63	96
Non-Active:			
Associate Members	1	3	4
Students	..	2	2
	1	5	6

This represents an increase in membership of one regular and one non-active during the past year.

Financial Statement

(For the year ending December 31st, 1934)

Receipts		
Interest on savings	$ 5.24	
Rebates from Headquarters	159.90	
Journal subscriptions collected	10.00	
Affiliates fees	18.00	
Entertainment receipts	121.75	
Excess of disbursements over receipts	66.31	
		$381.20
Disbursements		
Administrative expense	$ 25.00	
To Headquarters for loan of 1919	50.00	
Journal subscriptions paid	10.00	
Postage and telegraph	26.63	
Entertainment expense	202.56	
Stationery	55.01	
Flowers for funerals	10.00	
Insurance	2.00	
		$381.20
Assets		
Savings account	$198.00	
Current account	104.59	
Cash on hand (stamps)	2.77	
Property	1.00	
Unexpired insurance	1.80	
Accounts receivable	6.00	
		$314.16
Liabilities		
Accounts payable (honorarium, 1934)	$ 25.00	
Capital Surplus	289.16	
		$314.16

Respectfully submitted,

E. M. MacQuarrie, A.M.E.I.C., *Chairman.*
H. O. Brown, A.M.E.I.C., *Secretary-Treasurer.*

Toronto Branch

The President and Council:—

On behalf of the Executive committee, we submit the report of the Toronto Branch for the calendar year 1934.

The Annual Meeting of the Branch was held on March 29th, 1934, and the officers for 1934-35 were elected. During the autumn J. M. Breen, A.M.E.I.C., was transferred to Montreal, and Wills Maclachlan, M.E.I.C., was appointed to the vacancy thus created on the Executive, to complete the unexpired portion of Mr. Breen's term of office.

Following the Annual Meeting, the undermentioned were named chairmen of the Standing Committees:—

Papers........................R. E. Smythe, A.M.E.I.C.
Finance........................W. E. Bonn, A.M.E.I.C.
Publicity........................A. U. Sanderson, A.M.E.I.C.
Meetings and Reception........W. G. Chace, M.E.I.C.
W. W. Gunn, A.M.E.I.C., *Vice-Chairman*
Membership........................J. M. Breen, A.M.E.I.C.
Student Relations..............O. Holden, A.M.E.I.C.
Branch Editor..................J. M. Oxley, M.E.I.C.

The Executive committee of the Branch held seventeen meetings for the transaction of Branch business.

Twelve regular meetings of the Branch were held, as follows:—

1934

Jan. 18.—**Planning Toward Economic Recovery** by Professor Gilbert E. Jackson, Professor of Political Economy, University of Toronto. This meeting was arranged with the co-operation of the Canadian Political Science Association. Attendance, 60.

Feb. 1.—**Valuation and Depreciation** by W. J. Moulton-Redwood. Attendance, 40.

Mar. 1.—**The Status of the Engineer in Industry**, a paper prepared by J. B. Carswell, M.E.I.C., H. B. Stuart, A.M.E.I.C., and E. P. Muntz, M.E.I.C., of the Hamilton Branch, and presented by Mr. Carswell before a joint meeting of the Hamilton and Toronto Branches. Attendance, 100.

Mar. 19.—**Discussion of the Proposed Amendments to the By-laws of The Institute.** Attendance, 20.

Mar. 29.—Annual Meeting. Attendance, 25.

April 13.—**The Contribution of the Aeroplane to Canadian Industrial Development** by Mr. W. B. Burchall, advertising publicity manager of Canadian Airways, Limited. Attendance, 50.

April 19 and April 20.—**Can the Canadian Construction Industry be Stabilized?** A two-night joint meeting of the Toronto Branch of the Canadian Political Science Association, the Ontario Association of Architects; Hamilton Branch E.I.C.; Ontario Section A.S.M.E.; Toronto Branch A.I.E.E.; Toronto Branch Am. Soc. H. and V. Eng.; Ontario Chapter A.S.M.; Toronto Branch Ill. Eng. Soc.; Toronto Branch I.R.E.; Toronto Branch S.A.E.; Toronto Branch E.I.C. Attendance, 150 at each meeting.

Oct. 12.—**The Boulder Dam** by Dr. W. M. White, D.Sc., manager and chief engineer of the Hydraulic Department of Allis-Chalmers Manufacturing Company. A joint dinner meeting of the Toronto Branch E.I.C.; Ontario Section A.S.M.E.; Toronto Section A.I.E.E.; Canadian Section S.A.E.; Ontario Chapter A.S.M. Attendance, 400.

Nov. 1.—Vickers-Armstrong films. Attendance, 150.

Nov. 22.—**The Relations between the Structural Engineer, Engineers Concerned with Mechanical and Electrical Installations, the Architect, the Fabricator, and the Contractor.** A general discussion by the Members. Attendance, 60.

Dec. 13.—**Welding** by Mr. David Boyd, Dominion Bridge Company, Limited. The American Society of Metals and the Ontario Section of the A.S.M.E. also joined in this meeting. Attendance, 150.

It will be noted that quite a number of the meetings have been held jointly with other engineering societies, and these have proved most enjoyable. Joint meetings with the Hamilton Branch have also been held. Dinner is frequently arranged for previous to the meetings, and while the numbers attending have been encouraging, it is regretted that more members do not avail themselves of these pleasant gatherings.

In spite of reduced receipts, the Branch has been able to keep its expenditures well within its income.

The Toronto Branch E.I.C. Loan Fund, established two years ago for the assistance of members, is in a satisfactory condition. Requests for assistance from this fund for the past year have been very few, and from present indications it would seem that it would not be necessary to ask for further contributions. The employment situation has improved considerably, so far as the members of the Branch are concerned, during the present year and it is confidently hoped that this improvement will continue during the coming year.

The membership of the Branch as at December 31st, 1934, is made up as follows:—

	Resident	*Non-Resident*	*Total*
Members	96	4	100
Associate Members	196	15	211
Juniors	46	1	47
Students	74	16	90
Affiliates	4	1	5
Branch Affiliates	1	..	1
Total—1934	417	37	454
Total—1933	461	40	501
	−44	−3	−47

It is with regret that we record the death of the following members of the Branch during the past year: William Gore, M.E.I.C., James Milne, M.E.I.C., L. W. Wynne-Roberts, M.E.I.C., and C. R. Scott, A.M.E.I.C. Our heartfelt sympathy is extended to their families in their loss.

FINANCIAL STATEMENT
(For calendar year 1934)

Receipts

Bank balance, January 1st, 1934		$765.96	
Affiliate fee	$ 10.00		
Bank interest	15.25		
Rebates and Branch News	552.60		
		577.85	
			$1,343.81

Expenditures

Affiliate, Journal subscriptions	$ 2.00	
Printing and notices of meetings	180.62	
Room rental and meeting expenses	23.00	
Entertainment of guests	12.80	
Gratuities	10.00	
Flowers	13.00	
Stenographic services	52.50	
Advertisement—"Transactions"	20.00	
Chairman's expenses, Annual Meeting	37.85	
Secretary's honorarium and expenses	149.55	
Postage	18.00	
	$519.32	
Bank balance, January 2nd, 1935	824.49	
		$1,343.81

Respectfully submitted,
R. E. SMYTHE, A.M.E.I.C., *Chairman.*
W. S. WILSON, A.M.E.I.C., *Secretary-Treasurer.*

Vancouver Branch

The President and Council:—

We beg to submit the following report of the activities of the Vancouver Branch during 1934.

MEETINGS

Six general meetings of the Branch were held, as follows:—

1934

Jan. 8.—Joint Meeting with A.I.E.E., Vancouver Branch. A. G. Dickenson, electrical engineer of Consolidated Mining and Smelting Co., on **Utilization of Electrical Energy at the Trail Smelter and Refinery.**

Feb. 12.—Brig.-Gen. Sir Charles Delme-Radcliffe on **The Nistri Three Dimensional Method of Photogrammetrical Surveying.**

Mar. 12.—H. N. MacPherson, A.M.E.I.C., on **The Preservation of Timber.** Illustrated with motion pictures.

April 12.—R. Rolleston West on **The Scientific Side of Flight.**

May 10.—Dominion Government 5-reel motion picture, **From the Ground Up**, dealing with the manufacture of automobiles.

Nov. 19.—Annual Meeting.

The average attendance was 49.

Seven Executive meetings have also been held since the last Annual Meeting.

INSTITUTE DEVELOPMENT

The past year has witnessed the decision of the corporate membership of The Institute to reject the By-law Amendments sponsored by the 1932-33 Committee on Development, which proposed a radical change in Institute grades and qualifications, aimed to broaden the basis of its membership by lowering its standards of admission. Our interpretation of this occurrence is that Institute members as a whole have declined to forsake their conception of The Institute as being a body of engineers, strictly professional in character. Although the 1933 Executive committee withdrew its objections in the interests of harmony, after gaining some modifications of the Committee on Development's original proposals, the 1934 Executive committee cannot but admit considerable satisfaction in the final outcome.

In July, 1934, during the Western Professional Meeting at Vancouver, the President, F. P. Shearwood, M.E.I.C., addressed the Executive committee on matters of special interest to Western Branches, most of which were definitely concerned with the problem of Institute Development and Institute relations with the provincial professional associations. The sincerity and earnestness of purpose that marked the President's effort, together with his frank invitation to submit our views on the matters in question, has opened a new channel for exchange of opinions that is very opportune under the circumstances of the moment.

Acting in the spirit of this invitation, a carefully prepared statement of views was approved by the Executive committee at a meeting in October, copies of which were forwarded to the President and all members of Council prior to the meeting of Council held in Toronto on October 19th.

JOINT CONVENTION OF THE E.I.C. AND A.S.C.E.

The principal event of the year was the very successful Joint Engineering Convention held by The Institute and the American Society of Civil Engineers at Hotel Vancouver, Wednesday, July 11th to Saturday, July 14th. Arrangements were in the hands of a local

Joint Committee with E. A. Cleveland, M.E.I.C., as Chairman, and J. C. Oliver as Secretary-Treasurer. The technical sessions held during the first two days were of exceptional interest, and the entertainment features which followed were no less successful. The convention provided a unique opportunity for local engineers to come in contact with distinguished men in their own special branch.

ASSOCIATION OF PROFESSIONAL ENGINEERS

The President and Registrar were again honorary members of the Executive.

WALTER MOBERLY MEMORIAL PRIZE

The 1934 winner is D. Lawrence McMullan of Salmon Arm, B.C.

MEMBERSHIP

	Resident	*Non-Resident*	*Total*	*Non-Active List*
Members	45	10	55	5
Associate Members	53	27	80	5
Juniors	7	7	14	3
Students	19	7	26	6
Affiliates	4	..	4	..
Branch Affiliates	1	..	1	..
	129	51	180	19

The Executive decided to proceed as in 1933 and hold the elections by secret ballot at the Annual Meeting, nominations to be received at the meeting signed by two Corporate members.

FINANCIAL STATEMENT

The attached statement shows a balance of $33.25 on hand at November 15th, 1934.

Receipts

Bank balance, November 15th, 1934		$ 43.01	
Bank interest—(November 30th, 1933 and May 31st, 1934)		1.50	
Rebates from Headquarters—May 1933 to April 1934, inclusive		233.75	
Branch News		14.75	
Fees, Branch Affiliate		5.00	
			$298.01

Disbursements

Office expenses:			
Rent	$ 50.00		
Petty cash	20.23		
Stenographer	15.00		
Telegraphs	3.90		
Exchange on rebate cheque	.25		
		$ 89.38	
Honorarium to Secretary for 1933		50.00	
Rebates to Headquarters:			
Contribution to Plenary Meeting of Council	39.00		
Journal subscription for Branch Affiliate	2.00		
		41.00	
Meetings:			
Printing and mailing	30.58		
Auditorium rental	41.25		
Express and operation for motion picture	10.55		
Lantern rental	2.00		
		84.38	
Bank balance, November 14th, 1934	33.48		
Less owing to Secretary—Petty cash	.23		
		33.25	
			$298.01

WALTER MOBERLY MEMORIAL FUND

Receipts

Bank balance, November, 1933	$ 92.41	
City of Vancouver Bond interest	25.00	
Dominion of Canada Bond interest	5.00	
Bank interest, November 1933, May 1934	2.58	
		$124.99

Disbursements

Safe keeping charges	$ 1.00	
Bursar, University of British Columbia	25.00	
Bank balance, November, 1934	98.99	
		$124.99

BONDS HELD IN TRUST

City of Vancouver No. 663—5%—1963	$500.00	
Dominion of Canada No. T.A. 065189—5%—1943	100.00	
		$600.00

Audited and certified correct:
T. V. BERRY, A.M.E.I.C.

Respectfully submitted,
P. H. BUCHAN, A.M.E.I.C., *Chairman.*
A. E. GORDON, Jr.E.I.C., *Secretary-Treasurer.*

Victoria Branch

The President and Council:—

The undersigned have the honour to submit the following report on the activities of the Victoria Branch of The Engineering Institute of Canada during the calendar year 1934.

MEETINGS

The Branch met on seven occasions, the average attendance, including visitors, being 32. Only one technical paper was presented to the Branch, a most interesting paper by Norman Yarrow, A.M.E.I.C., on the launching of ships, which was followed by a showing of the six reels of Vickers-Armstrong films, obtained through arrangements made by Headquarters.

Earlier in the year the Branch, on its own initiative, obtained a film entitled **From the Ground Up** dealing with the Automobile Industry in Canada. A small hall was hired for this meeting and printed tickets issued to persons interested or engaged in the industry locally, and some 70 persons attended. In organizing this meeting, the Executive committee had in mind the desirability of occasionally arranging meetings which are of general technical interest. The cost of this meeting was rather heavy.

Other meetings included three luncheon meetings, one visit to H.M.S. *Norfolk*, and one social meeting, namely, the Annual Bridge Party which has proved to be a most popular and inexpensive function, largely due to the courtesy of Mr. and Mrs. F. C. Green, who again kindly placed their home at the disposal of the Branch.

There were five meetings of the Executive committee with an average attendance of 90 per cent. It is the custom in this Branch to hold the Executive committee meetings in the evening at the homes of various members, an arrangement which has been very successful in securing a good attendance, and it ensures that every item of business is thoroughly discussed, which would not always be the case if meetings were held down town in less comfortable surroundings.

MEMBERSHIP

Our total membership shows a net loss of three. We gained one new member and one new associate member from the efforts of the membership committee. In addition, one member, one associate member, one junior, and one student, were transferred to Victoria.

One member and one associate member left Victoria; one associate member and one affiliate resigned. Four students were removed from the list for non-payment of dues, and we lost one member through the untimely death of K. M. Chadwick, M.E.I.C., past Secretary, Vice-Chairman, and Councillor of the Branch.

Membership now stands as follows:—

Members	20
Associate Members	33
Junior Members	4
Student Members	6
Branch Affiliate	1
	64

The average total membership, since 1918, is 68: maximum is 89; minimum, 55.

WESTERN PROFESSIONAL MEETING

This meeting, held in July, 1934, at Vancouver, was well attended by members of the Victoria Branch. Two papers by members of the Victoria Branch were presented at this meeting and subsequently published in The Journal, these being **Highways and Highway Transportation in British Columbia** by Patrick Philip, M.E.I.C., and **The Columbia River Basin** by J. C. MacDonald, M.E.I.C.

VISIT OF PRESIDENT AND SECRETARY

The Victoria Branch was honoured by a visit from Mr. F. P. Shearwood, M.E.I.C., and Mr. R. J. Durley, M.E.I.C., who remained two days in the city. At a well attended luncheon meeting, Mr. Shearwood addressed the members outlining his views on matters concerning the future of The Institute. Through the courtesy of the Vancouver Branch, a copy of Mr. Shearwood's address was mimeographed and sent to all members of the Branch.

Mr. Durley also addressed the members and explained several matters which were brought up by members.

FINANCES

Attached is a copy of the financial statement; expenditures exceeded receipts by $6.56; revenue was $120.15, being considerably less than the previous year. The Branch continued to function without any dues, other than the rebates from Headquarters—this has been made possible by giving up the room formerly rented in town and by sundry other economies. It is considered, however, that the total revenue of $120.15, which is less than $2.00 per member, is the minimum under which the Branch can continue to function.

UNEMPLOYMENT

During the year it was reported that six of the Branch members previously unemployed had obtained employment, either temporary or permanent, and at the time of writing it may be said that as far as is known, there are no cases of need as far as the Victoria Branch members are concerned.

The Annual General Meeting of the Branch was held on December 4th, 1934, when the officers were elected for the year 1935.

In concluding this report, we wish to express our thanks and appreciation of the unfailing courtesy and assistance we have received from the Secretary and Assistant Secretary at Headquarters in all matters.

Financial Statement

Receipts

Balance in hand, December 31st, 1933			$102.89
One Branch Affiliate's dues	$ 3.00		
Rebates	111.90		
Branch News	5.25		
			120.15
			$223.04

Disbursements

Contribution to Plenary Meeting	$ 14.00	
Cost of meetings	30.71	
Entertainment of guests	10.03	
Stenographer	23.17	
Mimeographing	24.19	
Postage and cheque stamps	10.97	
Telegrams and telephones	2.74	
Two wreaths	10.50	
Exchange on cheques	.40	
		$126.71
Balance in hand, December 31st, 1934		96.33
		$223.04

Audited and found correct,
W. M. Everall, A.M.E.I.C., Auditor.
Respectfully submitted,
H. L. Swan, M.E.I.C., *Chairman.*
I. C. Barltrop, A.M.E.I.C., *Secretary-Treasurer.*

Winnipeg Branch

The President and Council:—

The following annual report of the Winnipeg Branch for the year ending December 31st, 1934, is respectfully submitted.

The membership of the Branch is tabulated below.

	Resident	*Non-Resident*	*Total*
Members	28	4	32
Associate Members	61	16	77
Juniors	6	2	8
Students	27	3	30
Affiliates	2	..	2
Branch Affiliates	2	..	2
	126	25	151

There were held during the year 12 meetings of the Branch, particulars of which are given below.

1934

Jan. 4.—**Iron Debts and Rubber Dollars** by R. D. Colquette, Editor The Country Guide. Attendance, 46.

Feb. 1.—**Outline and Operation of Public Works Administration of N.R.A.** by Wm. Nelson Carey, Federal Engineer P.W.A., Minnesota. Attendance, 100.

Feb. 15.—Electrical film exhibited. Attendance, 46.

Mar. 1.—**Electric Soil Heating** by J. W. Tomlinson, Jr., engineer, Winnipeg Electric Company. Attendance, 46.

April 5.—**The Beauharnois Project** by A. E. Grassby; **Aerial Navigation** by Walter Murray, S.E.I.C.; **Public Works Projects** by Wallace Walkey. Attendance, 66.

Note.—These young speakers, members of the Junior Engineers Association, co-operated with the Branch for the delivery of the above mentioned addresses and succeeded in making a very interesting event of this meeting.

June 25.—Visit of General Secretary R. J. Durley, M.E.I.C., and the Junior Engineers Association. Attendance, 51.

July 27.—Visit of President F. P. Shearwood, M.E.I.C., who addressed the meeting on **Unusual Problems in Steel Bridge Erection.** Attendance, 57.

Oct. 4.—**Science in Naval Warfare** by Prof. J. F. T. Young, Department of Physics, University of Manitoba. Attendance, 53.

Oct. 18.—**The Geology of the Great Plains** by Dr. L. S. Russell, Geological Survey of Canada. Attendance, 79.

Oct. 25.—Special joint meeting with Association of Professional Engineers of the Province of Manitoba for the discussion of a report by J. W. Sanger, A.M.E.I.C., and E. V. Caton, M.E.I.C., on the subject of Joint Control of the Branch and Association. Attendance, 72.

Nov. 1.—**Germany of Today** by Prof. Fieldhouse, Professor of History, University of Manitoba. Attendance, 84.

Nov. 15.—**Science of Lighting** by J. Greenlaw, B.Sc.; **A New Process of Metallization** by W. Peterkin, B.Sc. Attendance, 66.

Dec. 6.—On this date, the usual meeting was replaced by a Smoker held jointly with the Association of Professional Engineers, the Canadian Institute of Mining and Metallurgy and the Association of Manitoba Land Surveyors. This function was largely attended and was voted a great success.

The average attendance at Branch meetings is 64, which, considering that two of the principal meetings took place in the summer months, when many of the members were absent from the city, is very gratifying.

The Branch was especially fortunate this year in having as visitors the General Secretary in June and the President in July.

Many matters of importance in Institute affairs were discussed with the President and Secretary by which a better understanding was arrived at. The events of a more social nature, the luncheon at which Mr. Durley met the members, and the dinner at Lower Fort Garry at which Mr. and Mrs. Shearwood were the guests of honour, were of a very enjoyable nature, and the members of the Branch feel that it would be a very fine thing if visits from the President and General Secretary could become annual events.

Very lively interest was taken in the proposal to try for a year to have joint executive control of the Branch and the Association of Professional Engineers of the Province of Manitoba, as a first step to complete co-ordination of the functions of these two bodies with the ultimate object of Federal amalgamation of The Institute and the several Provincial Associations or Corporations of Professional Engineers. A report on this subject was prepared by Messrs. J. W. Sanger and E. V. Caton, and the report was considered and discussed by the Executive committee of the Branch and the Council of the Association. So favourably were these bodies impressed with the possibilities of the suggestions outlined in the report, that it was decided to assemble a joint general meeting of the members of both bodies. This was done and the reaction of the meeting was such that questionnaires and ballots were circulated so that all who were not present at the meeting might record their views.

However, upon return of the ballots and questionnaires it was found that of the Association members, 74 were in favour of joint executive control, and 52 against. Of The Institute members, 58 were in favour of joint executive control, and only 1 against. It therefore seemed advisable to the Executive committee and Council to postpone any further efforts for the present but to make it a point to request the incoming Committee and Council to give this matter further special study with the hope that it may be again presented to the members of both bodies in an improved form.

Financial Statement

Receipts

Bank balance, December 31st, 1933	$143.69	
Rebates, last 3 months of 1933	36.38	
Branch News, December and November 1933	5.63	
Voluntary contributions from members	29.00	
Rebates, first 9 months of 1934	212.38	
Profit on conversion of Bond	8.28	
Profit, dinner at Lower Fort Garry	4.35	
Contribution, Manitoba Land Surveyors	10.00	
Contribution, Association of Professional Engineers	25.00	
Bond interest	25.00	
Bank interest	.93	
Dues and Journal subscription, Branch Affiliates	5.00	
Deposit, credit G. E. Baldry	15.00	
Rebates, last 3 months of 1934	29.87	
		$550.51

Expenditures

Joint Committee on Unemployment for 1932 and 1933	$113.36	
Honorarium to Secretary	50.00	
Purchase of typewriter	10.00	
Expenses, Carey meeting	56.87	
Safekeeping of bond	1.00	
Flowers	3.00	
Share of Plenary Meeting of Council, 1933	39.70	
Multigraphing and printing	111.00	
Addressograph	16.40	
Postage and petty cash	20.00	
Telegraphs	6.55	
Janitor services	5.00	
Refreshments at Branch meeting	3.70	
		$436.58

Cheques outstanding at December 31st, 1934:

	$ 7.14
	51.54
	$58.68
Balance in bank, December 31st, 1934	$155.37

Accounts payable:

Headquarters Journal subscriptions—Branch Affiliates, 3 at $2.00	$ 6.00
E. W. M. James, re G. E. Baldry	5.00
C. N. Telegraphs	.90
	$ 11.90

Respectfully submitted,
A. J. Taunton, A.M.E.I.C., *Chairman.*
Eric W. M. James, A.M.E.I.C., *Secretary-Treasurer.*

THE
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VOLUME XVIII FEBRUARY 1935 No. 2

Engineering Progress in the State of Victoria and The Melbourne Centenary

A recent issue of the Journal of the Institution of Engineers, Australia, contains a series of articles giving the historical record of one hundred years of engineering enterprise in the State of Victoria. The story is a striking one, and some of its features are of particular interest to Canadians as involving problems of a kind familiar to the Canadian west, particularly as regards irrigation and rural water supply in areas of low rainfall, and the utilization of large deposits of lignite. The natural resources and the transportation facilities of the State appear to have been developed in most cases under public control or ownership rather than as a result of private enterprise.

The eastern part of the State is mainly a plateau from 1,000 to 2,000 feet high with some peaks over 5,000 feet; the mountain slopes are forest-clad, and much of the timber is of large size.

The northwest portion of the State is more level, and sections of it have lower rainfall (from ten to twenty inches), particularly on the northern plains extending to the Murray river, which flows to the northwest, divides Victoria from New South Wales and is the principal source of water supply for the arid districts. As in the Canadian west, large areas of land where precipitation is small, only require a moderate additional supply of moisture to become extremely productive.

Irrigation projects in Victoria were contemplated as early as 1860, but it was not until 1886 that extensive development took place under the provisions of the State Irrigation Act, which was passed in that year. This act was somewhat revolutionary, because it vested in the Crown the right to use the water in any stream, lake or swamp, provided for the extinction of any riparian rights that might prevent the use of water for irrigation, authorized the construction of national works by the State, and enabled local authorities to carry out their water conservation schemes with money advanced from the public treasury.

Later, in 1904, another Water Act dealt more particularly with rural water supply and effected complete centralization of all water resources under a State Rivers and Water Supply Commission. Under this legislation the beds and banks of all streams became the property of the Crown, so that in the State of Victoria streams and other natural sources of water supply are now completely nationalized.

The first important irrigation project involving high-lift pumping on a large scale was at Mildura on the Murray river. A large part of the drainage area of that river lies in the State of New South Wales, so that both States are concerned in the utilization of its waters, accordingly the large irrigation storage at Hume on the Murray is a joint undertaking. The Hume dam is over a mile long, 106 feet high and stores 1,250,000 acre-feet of water.

As regards irrigation in general, the area commanded by the 5,200 miles of irrigation channels is nearly two million acres, to which a very large addition will be made when the contemplated Yarrawonga dam across the Murray is constructed.

The domestic water supply of rural areas is also regulated by the Commission, which has paid close attention to the needs of rural municipalities and individual farmers. For this purpose local divisions known as domestic and stock supply districts are organized, and these cover some fifteen million acres of the agricultural lands.

Over one million acres of farming land are supplied by sub-artesian bores, and in other districts water for domestic and stock purposes is supplied by over 8,000 miles of channels filled by pumping or gravitation.

Farmers are required to provide excavated earthen storages on their farms which must be of sufficient capacity to meet all their water requirements for twelve months, and the Commission channels are run once only each year to fill them.

The magnitude of the task of supplying rural Victoria with water (quite apart from irrigation requirements) will be appreciated when it is noted that by channels, bores and other methods, about one quarter of the whole area of the State is artificially supplied with potable water for domestic and stock purposes, and that in this way areas, otherwise non-productive, have been added to its farming lands.

The State government has been no less active in the field of power supply and fuel utilization. The State Electricity Commission, formed in 1918 after a study of the fuel and water power resources of the State, embarked on a policy of power development, of which perhaps the most interesting feature is the electric generating station and briquetting factory at Yallourn, some 90 miles east of Melbourne, where an immense deposit of brown-coal (lignite) 180 feet thick, with 35-foot overburden, is mined on an open cut system and electrical energy is developed on the site for transmission at 132,000 volts.

Electric power is used for the removal of the overburden and the excavation and handling of the fuel, the amount produced being approximately 10,000 tons per day. The fuel as mined contains 65 per cent of moisture, and has a calorific value of 3,000 B.t.u. per pound. Some 1,200 tons per day are briquetted for transport, the briquetted fuel having a calorific value of 8,750 B.t.u., the remainder being used in the generating station and briquetting plant.

In addition to the brown-coal deposits, the State produces some half a million tons per annum of bituminous coal which is principally shipped to Melbourne.

In the early days, however, gold mining was the outstanding feature of the State's mineral industry. In 1851 remarkable discoveries of alluvial gold deposits were made at Ballarat and Bendigo. There was a phenomenal inrush of gold-seekers, and in 1852 there were 65,000 people in the mining camps of the district.

The alluvial workings later gave place to lode mining and in 1898 sluicing and dredging methods began to be applied to the alluvial deposits, much of the equipment being manufactured within the State. Within the past five years there has been a marked revival of the gold industry with an increased application of modern methods.

The city of Melbourne had its beginning in 1835 in a small settlement on the shores of Port Phillip, the large bay which gives access from the sea to the mouth of the Yarra river. The city had a population of 77,000 in 1851, the year when the State of Victoria was separated from New South Wales.

The sensational development of the gold fields during the next few years led to rapid growth which has since continued almost uninterruptedly, and Melbourne is now a city of over one million inhabitants.

Its site, like that of many Australian cities and towns, was originally determined by the existence of an adequate water supply, so that the city itself lies some distance from the mouth of the river. Round the shores of Hobson's Bay, the northern portion of Port Phillip, the suburbs extend for more than ten miles, while at the mouth of the river are the piers and wharves of Williamstown and Port Melbourne.

The city has fine public buildings, wide, well-kept streets, and extensive public gardens and parks. Melbourne is one of the great ports of the world, and its harbour can now accommodate vessels drawing 37 feet of water, as compared with a depth of 12 feet 6 inches in 1876. Over three thousand vessels used the port in 1933.

The provision of an adequate water supply for Melbourne has been made easy by the availability of well-forested catchment areas within a reasonable distance and these have been vested in the Metropolitan Board of Works. The four main reservoirs give a gravity supply and store twenty-three billion gallons.

The main drainage system of the city was planned in 1890, the sewage flowing to a main pumping station whence it is discharged to a sewage farm 16 miles distant. Rainfall and storm flow is sewered separately and discharged into the Yarra river and Port Phillip bay.

As regards transportation, the metropolitan area is provided with a modern system of electric tramways, although some portions of the original cable system established in 1885 are still in operation.

There are now more than 4,700 miles of railway (5-foot 3-inch gauge) in the 90,000 square miles of the State of Victoria.

Road development, particularly in the rural districts, is of more recent growth, but has been favoured by a temperate climate and the availability of excellent material. Highway construction in Victoria is based on contributions from municipalities and the State, aided in some cases by a Federal grant, the funds being administered under the Country Roads Board.

Over £14,000,000 have been expended on the system of main roads, developmental roads and State highways.

The development of mechanical and electrical engineering establishments in Victoria received its first impetus in connection with the early activity in gold mining. The construction of mining machinery was followed by that of agricultural implements, and in Victoria more recently the manufacture of pumping plants, locomotives, steel pipes and general machinery has become well established. Progress can also be noted in the electrical industry, particularly as regards transformers and switchgear, and there is at Geelong a large modern cement mill.

The centenary of the city of Melbourne is being celebrated this year and in connection with the celebrations, the Institution of Engineers, Australia, are holding an engineering conference which will take place from the 11th to the 16th of March, 1935. One of the principal features of this conference will be an historical review of the engineering developments of the State for the past one hundred years.

The Institution has invited The Engineering Institute of Canada, among other national engineering societies, to take part in the conference and to nominate an official representative.

In response to this invitation, Council expressed The Institute's thanks and has appointed as our delegate one of our members long resident in Australia. Accordingly The Engineering Institute of Canada will be represented at the conference by Mr. T. P. Strickland, M.Sc., (McGill), M.E.I.C., the chief engineer of the Melbourne and Metropolitan Tramways Board, who will convey to the conference and to the Institution the best wishes of The Institute, together with our congratulations on the remarkable engineering developments which have taken place in the State of Victoria and the city of Melbourne.

Meeting of Council

A meeting of Council was held at Headquarters on Friday, January 18th, 1935, at eight o'clock p.m., with President F. P. Shearwood, M.E.I.C., in the chair, and ten other members of Council present.

Dr. Lefebvre reported that good progress had been made in collecting data for the committee under his chairmanship which is preparing a communication on the Montreal and Ship Channel Water Levels for the Board which is investigating that problem. His committee would be able to report shortly.

The Annual Report of the Finance Committee and the auditors' statement were received and approved for presentation to the Annual Meeting.

Consideration was given to the question of those members in arrears for 1934, who would consequently be removed from The Institute list if the provisions of the by-laws were enforced. After discussion, on the recommendation of the Finance Committee, it was decided to continue these members on the roll of The Institute for the present, in order to give them an opportunity to liquidate their indebtedness or furnish explanations which will justify Council in waiving the provisions of the by-laws.

The Report of Council and the committee and branch reports for the year 1934 were received and approved for presentation to the Annual Meeting.

The membership of the Nominating Committee for the year 1935 was noted, and it was unanimously resolved that Major L. F. Grant, M.E.I.C., be appointed chairman of that committee.

The reports of the various medal and prize committees were received and approved for presentation to the Annual Meeting.

A resolution was presented from the Ottawa Branch, for transmittal to the Annual Meeting, suggesting that renewed steps should be taken to effect as early as possible closer unity with the Association of Professional Engineers.

The thanks of Council were voted to Mr. William Storrie, M.E.I.C., for his kindness in visiting and addressing The Institute members at Port Arthur, Winnipeg, Saskatoon, Edmonton and Regina.

Three resignations were accepted, a number of members were placed on the Non-Active List, one Life Membership was granted, and several special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:—

Elections		*Transfers*	
Member	1	Member to Assoc. Member	1
Associate Members	6	Junior to Assoc. Member	2
Juniors	2	Student to Assoc. Member	1
Students admitted	10	Student to Junior	1

The Council rose at eleven thirty p.m.

J. J. Traill, M.E.I.C.,
Chairman,
Annual Meeting Committee.

The Annual General and General Professional Meeting

FEBRUARY 7th, 8th and 9th, 1935

J. W. Falkner, A. M.E.I.C.,
Chairman,
Registration Committee.

C. S. L. Hertzberg, M.E.I.C.,
Chairman,
Papers and Meetings Committee.

A. U. Sanderson, A.M.E.I.C.,
Chairman,
Publicity General Committee.

Blank & Stoller Ltd.

C. J. Ingles, A.M.E.I.C.,
Chairman,
Finance Committee.

W. B. Dunbar, A.M.E.I.C.,
Secretary,
Annual Meeting Committee.

Committee of Toronto Branch in Charge of Arrangements

A. B. Crealock, A.M.E.I.C.,
Acting Chairman,
Annual Meeting Committee.

ROYAL YORK HOTEL, Toronto, Ont.

R. B. Young, M.E.I.C.,
Chairman,
Publicity re Attendance Committee.

W. E. Bonn, A.M.E.I.C.,
Chairman,
Entertainment and Hotel Committee.

W. S. Wilson, A.M.E.I.C.,
Secretary-Treasurer,
Toronto Branch.

G. H. Davis, M.E.I.C.,
Chairman,
Hotel Committee.

A. M. Reid, A.M.E.I.C., Chairman,
Entertainment and Excursions
Committee.

OBITUARIES

William Charles Adams, M.E.I.C.

It is with very deep regret that we record the death at Montreal on January 7th, 1935, of William Charles Adams, M.E.I.C.

Mr. Adams was born in Martin county, Minnesota, on September 10th, 1880, and graduated from the University of Minnesota in 1904 with the degree of E.E.

Following graduation Mr. Adams became connected with a number of electrical companies where he gained

W. C. Adams, M.E.I.C.

a wide and varied experience in the science of electrical communication, and in 1906 he joined the staff of the Western Electric Company, being engaged until 1908 on telephone equipment engineering. From that time until November 1909 he was inspector of apparatus manufactured in the company's New York shops, and was subsequently until 1913 engineering inspector of completed telephone control office equipment, being in charge of this inspection work for the last year and a half. From March 1913 until June 1914 he was in charge of all engineering inspection work at the company's Hawthorne plant at Chicago, and from that time until 1919 he was responsible for the detail inspection of material, tools and apparatus purchased by the company for its customers from other suppliers. In April 1919 Mr. Adams was transferred to the Montreal plant of the Northern Electric Company Limited as head of the Engineering Department and held that position until 1934 when he was appointed consulting engineer, reporting to the president.

Mr. Adams was a member of the Main Committee of the Canadian Engineering Standards Association, representing the Canadian Manufacturers' Association, and was the Northern Electric Company's representative in the American Society for Testing Materials. He was also a member of the Corporation of Professional Engineers of Quebec, the Telephone Pioneers of America, and the American Institute of Electrical Engineers.

Mr. Adams joined The Institute as a Member on May 17th, 1921, and took a keen and active interest in its affairs, having represented the Montreal Branch on Council in 1927, 1928 and 1929, and acted as Treasurer of The Institute in 1931 and 1932.

Charles James Fox, A.M.E.I.C.

It is with regret that we announce the death of Charles James Fox, A.M.E.I.C., at Vancouver, B.C., on November 20th, 1934.

Mr. Fox was born at Dublin, Ireland, on February 23rd, 1880, and received his early education in that city.

From April 1896 until February 1900 he was engaged on draughting surveying and general engineering work with the civil branch of the Royal Engineers, Dublin, and in the following year was designing and superintending the erection of steel frame buildings, etc., with Kennan and Sons, Dublin. In January 1901 he went to London and was on the staff of David Rowell and Company, and was later, until July 1905 with Dr. G. F. Deacon, consulting engineer, as his pupil and assistant on the design and construction of large water supply and hydraulic works. Coming to this country, Mr. Fox was for over four years with the Atlantic Quebec and Western Railway, in charge of design work in connection with steel bridge foundations, timber bridges, culverts, etc., and as resident engineer on three sections of construction and in complete charge of the carrying out of various bridge foundations, timber trestle bridges, and concrete retaining walls. Following this Mr. Fox was for six months resident engineer with the Alberta and Great Waterways Railway in Alberta, and was subsequently with the Canadian Northern Pacific Railway for three years, and with the Pacific Great Eastern Railway, in British Columbia, for two years. Mr. Fox served overseas for four years, enlisting at North Vancouver, and going to France as a sapper with the 1st Divisional Engineers. He received his commission in the field, and returned as a Captain, having been awarded the M.C. For the past fourteen years Mr. Fox has been in the engineering department of the Vancouver Harbour Commissioners being respectively chief draughtsman and later assistant engineer, which position he held at the time of his death.

Mr. Fox joined The Institute as an Associate Member on December 21st, 1915. He was active in Institute affairs and in those of the Vancouver Branch, on whose Executive Committee he served in 1931, 1932 and 1933.

Michael Joseph Murphy, A.M.E.I.C.

Deep regret is expressed in placing on record the death of Michael Joseph Murphy, A.M.E.I.C., which occurred at Moncton, N.B., on December 30th, 1934.

Mr. Murphy was born at Halifax, N.S., on June 4th, 1881, and received his early education in that city. He was

M. J. Murphy, A.M.E.I.C.

the son of the late Dr. Martin Murphy, M.E.I.C., a former President of The Institute.

He commenced his engineering career as a member of the survey staff on the Nova Scotia Eastern Railway in 1903-1903, and the following year was spent in the provincial engineer's office at Halifax. From April 1905 to March 1906 Mr. Murphy was engaged with the Halifax and South Western Railway, and from that time until April 1907 he was topographer and leveller on the Canadian Northern Railway in the provinces of Quebec and Ontario. Later in 1907 he was instrumentman on the construction of a spur line from the Algoma Central Railway to the Superior Copper Company's mine in Ontario, and in 1908 he was assistant engineer for a time on the Georgian Bay canal. From 1909 to 1914 Mr. Murphy was with a location party through the Rocky Mountains, and was then engaged on the construction of the Grand Trunk Pacific Railway through the mountain section in Alberta and British Columbia. In 1914-1915 he was assistant to the consulting engineer with the Canadian Government Railways, and in 1915 was appointed assistant engineer at Moncton, which position he held up to the time of his death.

Mr. Murphy became an Associate Member of The Institute on May 26th, 1920, and has always been keenly interested in Institute activities, having been vice-chairman of the Moncton Branch in 1929, and chairman in 1930.

John Herbert Larmonth, M.E.I.C.

Members of The Institute will learn with regret of the death at Montreal on January 3rd, 1935, of John Herbert Larmonth, M.E.I.C.

Mr. Larmonth was born at Montreal on May 19th, 1872, and was educated at the High School and McGill University, graduating from the latter institution in 1894.

After leaving college Mr. Larmonth was for a time in the locomotive shops and draughting office of the Grand Trunk Railway, Montreal, and was afterwards with the Laurie Engine Company. Moving to Ottawa, Mr. Larmonth worked in the office of C. H. Keefer, and subsequently was with the E. B. Eddy Company, Hull, as construction engineer. He was later for six months resident engineer under C. H. Keefer on hydraulic power house and dam construction at Peterborough, Ontario, and following this was for two years engaged on mechanical engineering work for the Quaker Oats Company at Peterborough, later becoming works manager of that company. Mr. Larmonth was also for five and a half years chief engineer and general manager for the Peterborough Hydraulic Power Company, the Peterborough Radial Railway Company and the Peterborough Light and Power Company, being for a short time general manager of the Electric Power Company. During the war Mr. Larmonth was connected with the Imperial Munitions Board as superintendent of the Steel Department, and in 1918 began practice as a consulting engineer in Montreal. Becoming interested in the railway supply business in 1922, he took over the representation of a number of companies, later becoming president of Engineering Materials Limited, the position which he held at the time of his death.

Mr. Larmonth joined The Institute (then the Canadian Society of Civil Engineers) as a Student on March 29th, 1894; on April 14th, 1904, he became an Associate Member, and on March 9th, 1912, a full Member.

PERSONALS

Gordon J. Jue, S.E.I.C., who graduated from McGill University with the degree of B.Eng. in 1932, is now located at Canton, China, where he is teaching at the Pui Ching Middle School.

Brigadier A. C. Caldwell, M.E.I.C., has retired from the position of Quartermaster-General, Department of National Defence, Ottawa, Ontario.

Brigadier Caldwell, who graduated from the Royal Military College in June, 1898, has had a long and distinguished career.

From December 1899 to February 1900 he was on the staff of the officer commanding Royal Engineers, western lines of communication in South Africa, and from April to November 1900 he was on the staff of the field intelligence department. In May 1901 he was appointed to the 14th Regiment as lieutenant, and in August, 1902, was transferred to the Canadian Engineers. In April 1903 he became Captain in the Corps of Guides, and in July 1903 he was appointed Intelligence Staff Officer, being promoted to the rank of Major in February 1904. In March 1905 he was transferred to the Royal Canadian Engineers as a Captain, and in July of the same year he was appointed assistant director of intelligence, becoming a Major with the Royal Canadian Engineers in October 1907. In May 1911 Major Caldwell was appointed chief engineer, 2nd Divisional area, and in May 1915 he was promoted to the rank of Lieutenant-Colonel, becoming Brevet Colonel in October 1917. In March 1918 he was appointed General Staff Officer Grade I, Militia Headquarters, and in June 1922 he became substantive Colonel, Royal Canadian Engineers, and was appointed Director of Engineer Services, Department of National Defence, Ottawa, Ont. On January 1st, 1930, he was promoted to the rank of Brigadier, and received the appointment from which he has recently retired.

Brigadier Caldwell became a Member of The Institute in 1927.

Brigadier W. H. P. Elkins, Affiliate E.I.C., formerly commandant of the Royal Military College, Kingston, Ontario, has been appointed officer commanding Military District No. 2, Toronto, Ontario. Brigadier Elkins graduated from the Royal Military College in 1905, and was subsequently a lieutenant in the Royal Canadian Horse Artillery. From May 1908 until February 1910 he served in India with the Royal Horse Artillery, and in November 1910 he was promoted to the rank of captain in the Royal Canadian Horse Artillery. From 1914 until 1919 he served overseas, commanding A. Battery R.C.H.A. in France from February until December 1916, and commanding the R.C.H.A. Brigade in France from the last mentioned date until the end of the war, when he returned to Canada in command of the Brigade, which he held until 1922. From 1920 until 1922 he was commandant of the Royal School of Artillery (Mobile), on post war reorganization from 1922 to 1925 he commanded the Royal Canadian Artillery, Halifax and was commandant of the Royal School of Artillery (Coast Defence and Anti-aircraft), from 1925 to 1926 he resumed the appointment which he had held in 1920-1922. In 1927 he was appointed staff officer, Artillery, Department of National Defence, Ottawa, and also chairman of the Standing Arms Committee, and in 1930 he received the appointment from which he now resigns.

Thomas W. Harvie, M.E.I.C., has retired from the position of general manager of the Montreal Harbour Commission, which he has held for some years.

Born in Scotland in 1877, Mr. Harvie was educated at the Glasgow and West of Scotland Technical College, later, from 1894-1899 serving his apprenticeship with Messrs. Kyle, Dennison and Frew, civil engineers, of Glasgow. In 1899-1900 he was assistant engineer with the same company, and in 1900 he joined the staff of the Caledonian Railway Company as assistant resident engineer. In 1902 Mr. Harvie entered the service of the Clyde Navigation Trust as assistant engineer, which position he held until 1904 when he became resident engineer for the Trust. From 1907 until 1910 he was agent and chief engineer on the construction of Yorkhill basins and quays for the Clyde Navigation Trust. Coming to Canada in 1910 Mr. Harvie was resident engineer on the construction of the new Victoria pier, shore wharves, etc., for the Montreal Harbour Commissioners, and in 1913 he was appointed assistant chief engineer, holding that position until 1922 when he became chief engineer, an appointment which he retained until his promotion to the office from which he now retires.

J. L. Busfield, M.E.I.C., has been appointed managing director of Gardner Engines (Eastern Canada) Limited, the Canadian subsidiary of Norris, Henty and Gardners Limited, of Patricroft, Lancs., England (manufacturers of the Gardner Diesel engine) operating in the territory from the Maritime Provinces to Saskatchewan.

Mr. Busfield was born in London, England, in 1888, and was educated at the City of London School and Dulwich College, and in 1907 graduated from the Central Technical College (City and Guilds Institute) and London University, receiving from the latter institution the degree of B.Sc., with honours in engineering.

J. L. Busfield, M.E.I.C.

Following graduation he came to Canada, and during the years 1907-1912 was with the eastern division of the Grand Trunk Railway, first on the resident engineer's staff and later as principal assistant to the resident engineer. In 1912 Mr. Busfield was appointed chief of party in charge of surveys with the Mount Royal Tunnel and Terminal Company in connection with the construction of the double-track tunnel through Mount Royal at Montreal. Subsequently he became assistant engineer in charge of surveys and alignment on the eastern division of the work and later office engineer in charge of the preparation of the terminal designs. In 1915 Mr. Busfield became engineer with the chairman of the Georgian Bay Canal Commission and was engaged in investigating the economic feasibility of that project. In 1916 he joined the staff of Walter J. Francis and Company as principal assistant, and during the following six years was engaged principally on hydro-electric work. In 1922 Mr. Busfield was a partner with de Gaspe Beaubien, M.E.I.C., in the firm of Beaubien, Busfield and Company, Montreal, and in this capacity was in charge of the construction of hydro-electric plants, reporting on numerous similar projects and other related work. In 1927 he entered the commercial sphere and became president of the firm of Busfield, McLeod Limited, successors to Chemical Engineering Equipment Company Limited, changed early in 1934 to J. L. Busfield and Company Limited, and in these later capacities acted as Eastern Canadian representative of Norris, Henty and Gardners Limited.

Mr. Busfield has been prominent in the affairs of The Institute for many years, having been secretary-treasurer of the Montreal Branch in 1919-1922; vice-chairman of the Branch in 1924, and chairman in 1925. He has served almost continuously on the Council of The Institute since 1926, and has been chairman at one time or another of such committees as Finance, Publication, Papers, Library and House, Remuneration of Engineers, Prizes, Development and others.

G. Gordon Gale, M.E.I.C., former vice-president and general manager of the Gatineau Power Company, has been made president of that company and also of the Canadian Hydro-Electric Corporation. Mr. Gale was educated at McGill University, obtaining the degree of B.Sc. in mining engineering in 1903, the B.Sc. in electrical engineering in 1904, and the M.Sc. in 1905. Following this Mr. Gale was for a time assistant engineer with the Canadian Rubber Company, becoming resident for Messrs. Ross and Holgate at Deschenes, Que., in 1907. Later in the same year he was appointed superintendent of power with the Hull Electric Company, holding that position until 1909 when he became acting general superintendent. In 1914 he was made general manager of the company and remained in that position until he was appointed general manager of the Gatineau Power Company.

ELECTIONS AND TRANSFERS

At the meeting of Council held on January 18th, 1935, the following elections and transfers were effected:—

Member

RIGGS, Henry Earle, B.A., (Kansas Univ.), C.E., (Univ. of Mich.), consltg. engr., 527 East Liberty St., Ann Arbor, Mich.

Associate Members

BAILEY, Charles David, engr., Dominion Bridge Co. Ltd., Montreal, Que.

BEATON, Neville, res. engr., Powell River Co. Ltd., Powell River, B.C.

BELANGER, René, B.A.Sc., C.E., (Laval Univ., Montreal), engr. and supt. of plants of Quebec Pulp & Paper Corpn., Société d'Eclairage et d'Energie Electrique du Saguenay, and Chicoutimi Mills, Ltd., Chicoutimi, Que.

JOHNSTON, Alexander Charles, elect'l. supt., Aluminum Company of Canada, Ltd., Arvida, Que.

PERRY, Aubrey Huffman, B.A.Sc., (Univ. of Toronto), asst. engr., Dept. of Pensions and National Health, St. Catharines, Ont.

STOBBART, William Morley, asst. engr., Dominion Bridge Co. Ltd., Montreal, Que.

Juniors

BECKER, Donald Fay, B.A., B.Sc., (Univ. of Alta.), secretary-treasurer, Richfield Distributors Ltd., Calgary, Alta.

BECKER, Howard Warren, B.A., B.Sc., (Univ. of Alta.), vice-president, Richfield Distributors Ltd., Calgary, Alta.

Transferred from the class of Associate Member to that of Member

ADDIE, George Kyle, B.Sc., (McGill Univ.), consltg. engr., Quebec, Que.

Transferred from the class of Junior to that of Associate Member

KILLAM, Donald Alexander, B.Sc., (McGill Univ.), designing engr., Canadian Industries Ltd., Montreal, Que.

STEPHENS, Donald McGregor, B.Sc., (Univ. of Man.), technical dftsman., Surveys Br., Dept. Mines and Natural Resources, Winnipeg, Man.

Transferred from the class of Student to that of Associate Member

CARVER, Stanley Cox, B.A.Sc., (Univ. of B.C.), asst. designing engr., Fleming Bros., Struct'l. Engrs., London, England.

Transferred from the class of Student to that of Junior

ADDISON, John Hillock, B.A.Sc., (Univ. of Toronto), engr. in charge of surveying, Minefinders Ltd., Noranda, Que.

Students Admitted

CADRIN, Paul Emile, (Ecole Polytechnique, Montreal), 123 Dorchester St. East, Montreal, Que.

CAMPBELL, Duncan Chester, B.Sc., (Univ. of N.B.), 210 Winslow St., West Saint John, N.B.

JEFFREY, James Stewart, (McGill Univ.), 2063 Stanley St., Montreal, Que.

KERSHAW, Norman William, B.Sc., (Univ. of Sask.), 2201 Dorchester St. West, Montreal, Que.

MARTIN, Colin Hector, B.Sc., (Univ. of Man.), Selkirk, Man.

PAPOFF, William Nikitovitch, B.Sc., (Univ. of Sask.), Cons. Mining & Smelting Co. Ltd., Trail, B.C.

SHERWOOD, Harris Mitchell, B.Sc., (Univ. of Alta.), 55 Second St., Medicine Hat, Alta.

SHORTALL, John Desmond, (McGill Univ.), 5094 Cote St. Antoine Rd., Montreal, Que.

THOMAS, James Macleod, B.Sc., (Univ. of N.B.), 236 Waterloo Row, Fredericton, N.B.

WOZNOW, John, (Univ. of Alta.), University of Alberta, Edmonton, Alta.

RECENT ADDITIONS TO THE LIBRARY

Reports, etc.

Institution of Civil Engineers (Great Britain):

Selected Engineering Papers:

No. 151—The Design of Piers for a Bridge or Sluice Dam; an Investigation with the aid of Model Experiments.
152—New Harbour Works, Three Rivers, Canada.
153—The Repair and Maintenance of Vertical Gas Retorts.
154—Failures in Steel and Cast-Iron Mains and Provisions for Their Protection.
155—The Port of Para Construction Works.
156—Taste and Smell Troubles in Bulawayo Water, with special reference to the Use of Activated Carbon.
157—The Carlton Bridge, Christchurch, New Zealand.
158—Transport Problems in Western Australia, with special reference to Railway Construction and Harbour Development.
159—Recent Remarkable Rains in Southern Rhodesia with certain deductions as to Probable Maximum Floods.
160—The Construction of No. 2 Graving Dock at Elderslie.
161—Tests on Cast-Iron Girders Removed from the British Museum.
162—The Strengthening of a Cast-Iron Bridge by Welded Steel Bars Encased in Concrete. The Holt Fleet Bridge near Worcester.
163—Circulating Water Culverts for the Portishead Generating Station of the Bristol Corporation.
164—Fundamental Assumptions in Reinforced Concrete Design.
165—Plain and Reinforced Concrete in Torsion with particular reference to Reinforced Concrete Beams.
166—The Construction of a Bridge over the River Benue at Makurdi, Nigeria.
167—The Stability of Tall Building Frames.
168—Methods of Determining the Thickness of Steel Plates and Castings.
169—Recent Extensions of Portslade (Brighton) Gas Works.
170—The Effect of Fluid-Pressure on the Permanent Deformation of Metals by Shear.
171—The Port of Suva, Fiji; Its History and Development.

American Concrete Institute: List of Members, 1934.
Canada: Report of the Minister of Public Works, 1934.
National Research Council, Canada: 17th Annual Report, 1933-1934.
American Institute of Mining and Metallurgical Engineers: Year Book, 1935.

Governor of the Panama Canal: Annual Report, 1934.

The Construction Trade: Review and Forecast, 1935. (Supplement of Daily Commercial News.)

Canada, Department of National Defence: Defence Forces List, 1934.

Technical Books, etc., Received

Suspension Bridges of Short Span, by F. H. Frankland. (*American Institute of Steel Construction.*)
Resistance of Materials, by F. B. Seely. (*John Wiley and Sons.*)
The Canadian Almanac, 1935.

BOOK REVIEWS

Suspension Bridges of Short Span

By F. H. Frankland, American Institute of Steel Construction Inc., New York, 1934. 6 by 9¼ inches, 128 pages, diagrams, photos. $3.50. Cloth.

This book is an endeavour to furnish in easily usable form, basic information on the design and construction of modern suspension bridges smaller in size than monumental structures such as the George Washington bridge.

Bridge engineers will find in this book the data necessary to make a complete design for suspension bridges of all types, with loaded or unloaded backstays, self-anchored or gravity-anchored, ordinary or multiple-span arrangements. The author notes the recent important advance in suspension bridge design brought about by the introduction of the generalized deflection theory.

Aesthetics and their relation to economics of design are discussed, a subject frequently omitted from books on the design of bridges.

The author deals with impact and explains his method of designing the entire cross section of the floor system and stiffening members as a unit to resist shear, bending moment, transverse wind and compression when a self-anchored design is used.

The chapter on multiple span bridges is timely in view of present tendencies in the United States practice.

A complete chronological table of suspension bridges with main spans of 800 feet and less, built since 1900, is included as is also a bibliography of seventy books and papers, in English and foreign languages, dealing with matters discussed in the book.

The book is well illustrated and adequately indexed.

An Introduction to Practical Organic Chemistry

By W. A. Waters, Longmans Green and Company, Toronto, 1934. 5 by 7½ inches, diagrams, etc. $1.10. Cloth.

Reviewed by Dr. E. E. Massey*

Dr. Water's purpose is to provide a laboratory manual for those students having a limited number of hours at their disposal for the study of practical organic chemistry. The aim is at a wide range of important reactions rather than depth of treatment.

The book consists of three sections, dealing respectively with technique, preparation and identification of organic compounds. The section on technique is more thorough than in many manuals of wide scope. This is to be commended, since it is common for students who have presumably completed a course of elementary preparations to be at a complete loss when required to carry out some simple fundamental process, mainly because the necessity has not occurred in the preparations which have been made. The section contains, in addition, useful paragraphs on such topics as "cleaning vessels," "decolorization of solutions," and "avoidance of bumping." In addition to details of technique, attention is paid to difficulties which are likely to occur in carrying out the processes. The preparations described are sufficient for a short course, though it might have been advisable to include a Grignard reaction or acetoacetic ester synthesis. Considerable emphasis is placed on the value of test tube reactions, a point frequently ignored in laboratory manuals in organic chemistry. The arrangement differs from that of many books on the subject. The author does not omit all compounds containing a benzene ring from sections dealing with reactions of aliphatic compounds. Hence, there is less likelihood of a student reaching the erroneous conclusion that the side chain of an aromatic compound behaves differently from an aliphatic compound. This often occurs where a rigid division is made between aliphatic and aromatic substances. The section dealing with identification is, in effect, an extension and summary of the reactions of the most important organic groups.

The type is good, and the book is comparatively free from misprints, these being limited to an occasional missing letter. Illustrations are, in general good, but on page 20 both tubules of a condenser are represented as exits, and in the sketches of separatory funnels the stop cock vent is at right angles to the correct position.

The author succeeds in accomplishing his purpose, and the manual should be especially valuable to those who are compelled to acquire their knowledge of organic chemistry while engaged in plant practice. It should be used in conjunction with an adequate theoretical treatment of the subject.

**Research Chemist, Donald-Hunt, Limited, Montreal.*

Mechanical Vibrations

By J. P. Den Hartog, McGraw Hill Book Company, New York, 1934. 6 by 9¼ inches. Figs., tables. $5.00. Cloth.

Reviewed by Professor A. R. Roberts, A.M.E.I.C.*

This book by Professor Den Hartog is intended to provide an introduction to the subject of mechanical vibrations to meet the needs of students and practising engineers. It is assumed that the reader is familiar with the mechanics and calculus of the usual engineering curriculum but a previous knowledge of differential equations is not essential. Equations of this type, when they occur, are discussed at length and the significance of the terms fully explained.

The first chapter deals with the kinematics of vibration and includes representation by vectors and complex numbers. The succeeding chapters are devoted to vibrating systems having one, two or more degrees of freedom, multicylinder engines, rotating machinery, self-excited vibration and to systems having non-linear characteristics. The concluding section contains a short appendix on the gyroscope, a fairly complete bibliography and answers to problems.

Numerous examples are worked out and these, together with the problems set at the end of each chapter, will be found to be of material assistance to the student.

Not the least important feature of the book is the introduction by the author of frequent references to illustrative examples which, to quote but a few, include hydraulic penstocks, ship stabilizers, turbine discs, wing flutter, floating power, galloping transmission lines, gear noises, oil whip in bearings.

As an authoritative treatment particularly well adapted for an introduction this volume can be highly recommended.

**Professor of Mechanical Engineering, McGill University, Montreal.*

Handbook of Chemistry

Compiled and edited by N. A. Lange, Ph.D., Handbook Publishers, Inc., Sandusky, Ohio, 1934. 5¼ by 8 inches, 1,545 pages, tables, etc. $6.00. Fabrikoid.

Reviewed by Dr. S. G. Lipsett*

Professor Lange has produced a comprehensive and commendable handbook for chemists. It contains 1,513 pages of tables and data without being cumbersome. In a book of this nature of course the value lies in the choice of the contents. It would be impossible to please everyone but on the whole this should be a handy reference book, both to the works chemist and to the research worker.

The tables on the properties of inorganic and organic compounds are quite complete. There are tables describing the properties of natural and synthetic resins, alloys, alkaloids, oils, fats, waxes and minerals. Many tables are devoted to the solubility of compounds at different temperatures and the specific gravity of solutions of different concentrations.

A number of tables include information of particular interest to physical chemists, such as vapour pressure, surface tension, viscosity, thermochemical data, spectra, etc.

A considerable amount of miscellaneous material is included in this handbook which will be found useful at the right occasion. For instance, there will be found information on analytical procedures, equivalents of volumetric solutions, materials of construction, corrosion-resistant materials, composition of foods, water treatment, ceramics, pipes and valves, freezing mixtures.

There is a considerable section devoted to mathematics and mathematical tables.

The basic formulæ and theorems in algebra, geometry, trigonometry and calculus are listed and described. Then follow tables of logarithms, trigonometric functions, powers, roots, reciprocals and many other tables of purely mathematic interest.

This handbook has fulfilled its function of presenting a vast amount of information in a small volume and should prove a valuable book to anyone engaged in chemistry or allied sciences.

Research Chemist, Donald-Hunt, Limited, Montreal.

Undertakings Without Precedent

Extracted from an editorial foreword in the *Engineering News Record* for November 29th, 1934, referring to a series of articles on a group of federal public works projects now under construction.

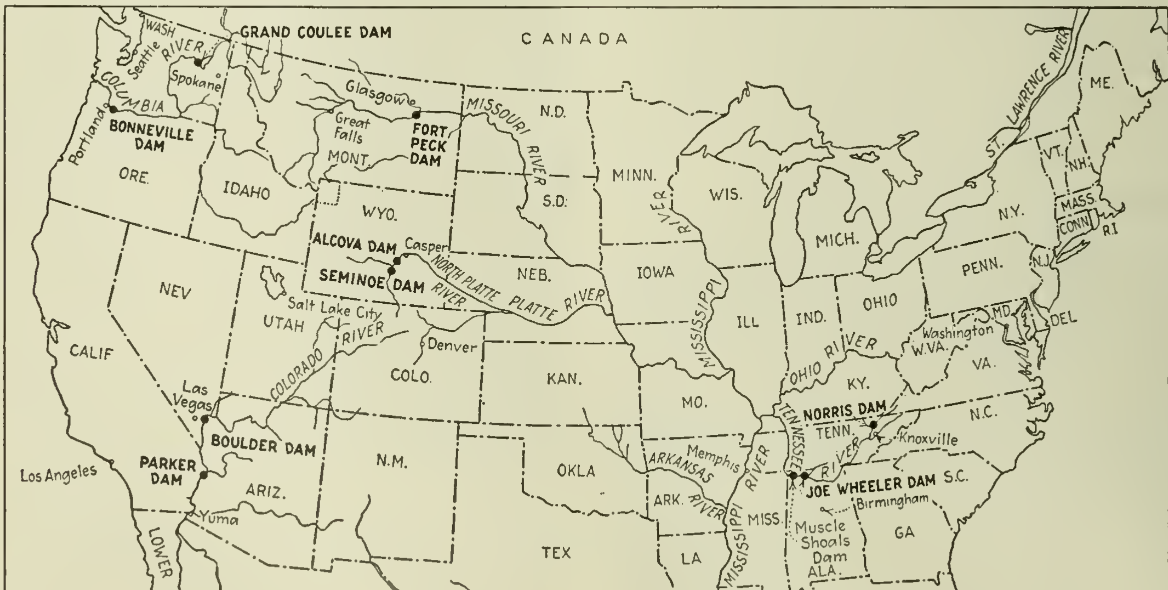
The federal government at the present time is engaged in the construction of a group of great projects for power development, flood control, navigation or water conservation, projects that will cost in the neighbourhood of $400,000,000 and will increase the nation's power-producing capacity by one million horse power. In the northwest the government is building a $63,000,000 dam for power development on the Columbia river near the mouth of the Grand Coulee, and at Bonneville on the same river it is building a combined power and navigation dam costing $32,000,000. In Black Canyon on the Colorado the government is building Boulder Dam, the greatest concrete dam ever attempted by man. At Fort Peck on the upper Missouri river the world's largest earth dam, estimated to cost $84,000,000, is under construction to regulate the flow of the Missouri as an aid to navigation, and, incidentally to produce power and provide water for a limited amount of irrigation. On the North Platte river in Wyoming a power and storage dam is to be built at Seminoe, and below it near Casper, work has begun on a diversion dam and irrigation project, the whole to cost $22,000,000. And, finally in the southeast there is under construction Norris dam on the Clinch river, costing $34,000,000; on the Tennessee river there is Joe Wheeler dam, costing $23,000,000; and as recently announced, Pickwick Landing dam at a cost of $22,000,000, all three being built by the Tennessee Valley Authority with federal funds. Except for Norris dam and the work on the Colorado river, this work is all being carried forward without specific Congressional approval, being authorized under the broad powers granted the President under the Recovery Act. Further, these projects are outside the normal programme of river control and land-reclamation work carried on by the Corps of Engineers and the Bureau of Reclamation, work planned far in advance of execution and undertaken only as authorized by Congress.

This is an unprecedented situation. For those who would look beyond the present spectacular construction operations to enquire into the purpose of the undertakings, it raises questions whose answers either never have been given or have been obscured by other matters. Why were the projects undertaken? How do they fit into plans for the orderly development of the river system on which they are located? How are they related to the economic development of their respective regions? Are they economically justified, either in part or as a whole? Is there a market for the power to be developed? Are the power plants logical additions to the power systems of the region in which they are located, or must the government enter into direct competition with existing electric utilities in order to develop a market? Will the land to be irrigated ever produce a return on the investment?

These and similar other questions are being asked by engineers on all sides. In this issue an attempt is made to answer as many of them as possible by setting forth the known facts upon which answers must be based.

Aside from their function in the employment-for-recovery campaign, these projects, other than those on the Colorado river, are outstanding physical expressions of a leading New Deal characteristic —the willingness to try out a promising or attractive idea even at stupendous cost, regardless of whether it meets the test of sound business procedure. It is what the President has often described as the experimental approach to the solution of national problems. Only the dire national emergency justified the method, of course.

With the exception of the great works on the lower Colorado and part of the construction work undertaken by the Tennessee Valley Authority, the projects are outgrowths not of planning and economic determination of service value, but of the dictatorship vested in the President by the emergency laws enacted by Congress in early summer of 1933. Social objectives and the desire to set up regulatory public power systems evidently were the motives in part. Political reasoning appears to have entered, at least to some extent. For example, Grand Coulee had never been planned as a government power enterprise, but instead had been conceived as part of a huge regional development based on irrigation, with power in large part a service feature for irrigation pumping. In this scheme, the dam and power plant were to cost nearly $200,000,000; and the whole project, because of its vast size in both money and other elements, was regarded as being far in the future. But local political demand for it was strong. The Administration, unwilling to allocate to the state of Washington so large a sum, fixed the amount at $63,000,000 to be spent for a power enterprise alone, and it then became necessary for the engineers of the



Map showing location of nine dams now under construction by the Federal Government.

Bureau of Reclamation to design a dam and power plant to fit this sum. In effect, the present Grand Coulee represents not a project that was worked out on its own merits, but merely $63,000,000 worth of dam.

And while even this minor Grand Coulee dam alone could supply all of the unsatisfied power needs of the northwest states for many years, Oregon too sought something for itself. Authorization of Bonneville resulted.

* * * * *

The favourable attitude of the administration toward public power development also had an important bearing on the financing of these projects. President Roosevelt went into the White House in 1933 fresh from a long contest with the electric utility interests in New York State, which resulted in the establishment of the New York State Power Authority, created expressly to undertake development of the great power resources of the international section of the St. Lawrence river as a means of checking the further exploitation of the state's power resources for private profit. In Washington he found the federal government already committed to a large power-generation programme in the southwest at Boulder dam, and with a white elephant on its hands in the southeast in the shape of the power plant at Muscle Shoals. Through the establishment of the Tennessee Valley Authority to take over the latter plant and supplement it with other plants, the President saw that it would be possible to dominate the power market in the southeast. Thus there was soon to be at hand what he termed a "power yardstick" both in the southwest and southeast. To round out control of the country, similar domination was needed in the northwest and the northeast. The St. Lawrence ultimately, the President believes, will provide a yardstick in the latter region; there remained still the northwest to be provided for. Bonneville and Grand Coulee provide that yardstick. The Bonneville project in theory is a navigation aid but it will produce a large amount of power. The Grand Coulee dam as now being built has power generation as its only objective.

This is the background against which the several projects discussed must be viewed. From a survey of the factors affecting the projects it will be seen that no one of them is so sound financially as to make it an attractive undertaking. But in an emergency like the present one the government is justified in looking beyond the immediate direct return to see whether an undertaking is sufficiently desirable as a national asset to warrant its construction.

Thus it is difficult to formulate a binding rule as to whether or not the federal government is justified in putting up the money to pay the cost of the projects reviewed in this issue. It should, however, be possible to state a general rule that no great power development should be undertaken without first having reasonable assurance that the power can be marketed in reasonable time without entering into destructive competition with existing plants. Were this rule applied, it is evident that some of the projects considered in this issue would not be undertaken.

Hydro-Electric Progress in Canada during 1934

The Dominion Water Power and Hydrometric Bureau of the Department of the Interior of Canada has issued Bulletin No. 1784, the annual review of hydro-electric and water power development throughout the Dominion during the year 1934, which gives a brief description of those undertakings which were begun or which reached the developed stage during that period and of extensions and replacements in existing plants.

This review discloses that during 1934 no new large water power undertakings were begun. Work was continued, however, on several developments already under construction and as a result net new installations aggregating 214,965 horse power were brought into operation during the year. This brings the total installation for the Dominion at the end of 1934 to 7,547,035 horse power. The recovery in power demand which was evident in 1933 gained momentum in 1934, and it is now evident from the monthly figures published by the Dominion Bureau of Statistics that the total output for 1934 will not only greatly exceed that of the previous year, but will establish a new high record. It is of special interest to note that this expansion of output is principally due to increased domestic, commercial and industrial demand, and not to increased export or secondary uses. The gain in output has been general but is most pronounced in the province of Quebec.

Copies of this bulletin may be obtained free of charge on application to the Director of the Dominion Water Power and Hydrometric Bureau, Ottawa, Ont.

Canadian Electrical Code

The Canadian Electrical Code, Part I, 3rd edition, has just been issued by the Canadian Engineering Standards Association. This succeeds the edition published in January 1930, and it is believed that it is now in accordance with up-to-date Canadian practice.

This Code has now been adopted by the nine provinces of Canada and in some provinces special provincial editions have been issued which consist of a special cover or an insert referring to legal regulations.

Copies of this publication may be obtained on application to the Secretary, Canadian Engineering Standards Association, National Research Building, Ottawa, the price being 25 cents per copy.

BRANCH NEWS

Calgary Branch

J. Dow, M.E.I.C., Secretary-Treasurer.
H. W. Tooker, A.M.E.I.C., Branch News Editor.

Commercial Aviation

A short address on Commercial Aviation presented by A. Griffin, M.E.I.C., chief engineer, Department of Natural Resources, C.P.R., and six most interesting reels of motion pictures dealing with Aviation, Steel Making and Ship-building, made up a programme given at a meeting of the Calgary Branch held on Thursday evening, December 13th, 1934, at which over sixty members of the Branch and their friends were present.

Scheduled commercial transport, or more particularly, the United Air Lines, operate ships (as they are now termed) from New York to San Francisco, Vancouver to San Diego and branch lines from Chicago to Kansas City and from Salt City to Spokane, Portland and Seattle, and also have inter-connections with various other air transport companies and with various railways.

It is of significance, the speaker said, that the early experimental stages were passed some years ago, since which scheduled service has been maintained with astonishing regularity in all but the worst weather and with a remarkable record of safety.

In describing the type of plane (Model 247) in use by the United Air Lines, the speaker pointed out that they had fifty in service carrying a crew of three, pilot, co-pilot and stewardess, and powered with two Pratt and Whitney engines, air cooled and mounted in the wings, and supercharged to develop 550 h.p. at 5,000 feet elevation. The plane is complete in all necessary facilities and when fully loaded carries ten passengers at 170 pounds each, plus 30 pounds of baggage per passenger, plus 747 pounds of cargo (mail and express). It has a cruising speed of 165 miles per hour and maintains an average speed of 150 miles per hour from San Francisco to New York. Gasoline consumption is at an average rate of one U.S. gallon per minute and costs about 60 cents per mile to operate. Engines are overhauled twice in sixteen hundred hours and at twenty-five hundred hours they are turned in for new ones, which may appear to be a short period but if put into miles it is more imposing at 130,000 miles between overhauls and a life of nearly 500,000 miles.

United Air Line planes, the speaker said, are equipped with a bewildering number and variety of instruments and controls, such as radio and a 50-watt crystal controlled telephone transmitter, and all useful aids to navigation.

When weather conditions require it, the pilot can follow the radio beam to the airport in almost any weather. This beam, the speaker understood, spreads about one mile in twenty each side of the course, and from it the pilot knows whether he is on his course or to one side.

While every effort is made to maintain fixed flying schedules, and this with a large measure of success, safety is a primary consideration. Passengers and sometimes mail and express are forwarded by train as required over those portions of the route where flying conditions are not safe.

Following Mr. Griffin's address the six reels of motion pictures were shown as follows: Steel Making, Aviation and Construction and Trials of the P. and O. steamers *Strathaird* and *Strathnaver*.

A very hearty vote of thanks was given the speaker and to those responsible for procuring the motion pictures, by J. Hadden, M.E.I.C.

The meeting adjourned at 10.15 p.m.

Tuesday, January 8th, 1935, was the occasion of a joint luncheon meeting of the Canadian and Rotary Clubs and the Calgary Branch of The Institute, held at the Palliser hotel. The subject of the address was "The Drought Situation in the Prairie Provinces" and the speaker was Mr. W. L. McTavish, editor of the Winnipeg Tribune.

The speaker said that large sections of fertile western farm lands had in the course of years been reduced to actual desert, and twenty million acres of the world's finest hard wheat land had been left to the depredation of sow thistle, and as a playground for gophers. Drought, recurring more frequently and with greater severity, teaming up with wind and soil drift, had caused irreparable damage.

The speaker was introduced by Dr. J. M. McCaffery, president of the Canadian Club, and a vote of thanks was tendered by G. P. F. Boese, A.M.E.I.C., chairman of the local Branch of The Engineering Institute of Canada.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.
C. Scrymgeour, A.M.E.I.C., Branch News Editor.

President's Address

During the month of December the Halifax Branch of The Engineering Institute of Canada held three meetings, the first on December 6th, this being the regular supper meeting held at the Halifax hotel with forty-five members present and under the chairmanship of R. L. Dunsmore, A.M.E.I.C., the guest for the evening being F. P. Shearwood, M.E.I.C., President of The Engineering Institute of Canada, who delivered a splendid address on Institute affairs, after which the meeting was thrown open to discussion and a large number of the members took part in a free expression of opinion on the affairs of The Institute relative to the present, past and future.

Bridge Construction

On December 7th a meeting was also held at the Nova Scotia Technical College at which the engineering students of the College and members of The Engineering Institute of Canada, totalling some two hundred or more, heard a particularly fine address by President Shearwood on "Bridge Construction." This meeting was under the direction of Professor Faulkner who, on behalf of the local Branch, expressed to Mr. Shearwood the great pleasure the Halifax members had had by his visit and by the addresses he had given during the two evenings he was their guest in the city of Halifax.

Annual Meeting

The annual meeting of the Halifax Branch was held in the Halifax hotel on December 20th at which the guest speaker was Squadron Leader Edwards, R.C.A.F., who spoke on the development of airways, aircraft and the Air Force in general since its inception in Canada, and also spoke on the development of Unemployment Relief Camps outlining their objects and achievements, the address being followed by a series of lantern slides. Following this address the annual business was enacted which included the reading of the reports of the various 1934 committees including the financial statement which showed a very creditable balance on hand.

In congratulating the new Council and introducing the new chairman, Howard Fellows, A.M.E.I.C., to the members, the retiring chairman, R. L. Dunsmore, A.M.E.I.C., expressed his appreciation of the fine support that the members of the Halifax Branch had given him during his year of office.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
V. S. Thompson, A.M.E.I.C., Branch News Editor.

The Annual Meeting of the Branch took the form of a dinner and smoker, and was held in the Wentworth Arms hotel on Tuesday, January 8th, 1935.

At the head table were H. B. Stuart, A.M.E.I.C., chairman of the Branch, W. Hollingworth, M.E.I.C., chairman elect, E. G. Cameron, A.M.E.I.C., vice-president of The Institute, F. W. Paulin, M.E.I.C., Councillor, E. E. Kent, representing the Hamilton Construction Association and several past chairmen of the Branch.

After the loyal toast had been honoured, Mr. Stuart expressed his pleasure at seeing such a representative gathering and welcomed specially the out of town guests. The Branch Secretary read the annual report which showed that the meetings of the year had been well attended, they presented subjects of wide variety and general appeal, and the place of meetings—McMaster University—was a home from home. There was a matter of a slight operating deficit for the year, the amount being $4.80, but nobody took it very seriously, and figured the money had been well spent.

Vice-President Cameron gave a short talk on Institute affairs. He spoke of the virility of the Branches, which really became the virility of The Institute. He told of the experiment which the Winnipeg Branch hoped to make by having the same personnel on the Executives of the Branch and the Professional Association. He touched briefly on the finances of The Institute, told of increasing revenue from fees which reflected improved condition of the engineer and his loyalty to The Institute in immediately making up arrears.

Councillor Paulin, who followed, told of the splendid work done by the President, Mr. Shearwood, and of the pleasure it had been to serve on the Council under him. Mr. Paulin thanked the retiring Executive for their loyalty and co-operation at all times.

E. H. Darling, M.E.I.C., past chairman of the Branch, who is the representative on the committee revising the city of Hamilton building by-laws, then gave a short talk. He explained the immensity of the task in getting up a set of by-laws, even when a model by-law drafted by the fire underwriters had been used to start with. Starting with this they had chopped and changed, so as to suit this department or that board, or some government edict as the case might be. It was not surprising therefore to learn that they were now at the third draft and it would probably all be rewritten before finally accepted by the city council.

On the motion of J. B. Carswell, M.E.I.C., the thanks of the Branch were tendered to Mr. Darling who, with H. S. Phillips, M.E.I.C., has worked assiduously on the revision of these by-laws.

The names of the new executive were then announced and Mr. Stuart asked Mr. Hollingworth, the new chairman, to take charge of the meeting, wishing him every success in his year of office.

After a few words of thanks and an appeal for the same support as his predecessor had been shown by the members of the Branch, Mr. Hollingworth introduced Mr. E. E. Kent, who brought felicitations from the Hamilton Construction Association and wished the Branch every success.

C. G. Moon, A.M.E.I.C., of the Niagara Peninsula Branch, spoke briefly and mentioned the possibility of a joint meeting and later on a trip along the Welland Canal, with the Niagara Peninsula Branch.

A number of the past chairmen of the Branch were then heard from: R. K. Palmer, M.E.I.C., E. P. Muntz, M.E.I.C., and H. A. Lumsden, M.E.I.C.

W. J. W. Reid, A.M.E.I.C., chairman of the Meetings and Papers committee, gave a brief outline of the papers he had lined up for the ensuing five months, the subjects including illumination, gold mining, Diesel engines, material handling and possibly welding.

Kingston Branch

L. F. Grant, M.E.I.C., Secretary-Treasurer.

The members of the Kingston Branch had the pleasure, on January 16th, 1935, of entertaining at dinner Mr. F. P. Shearwood, M.E.I.C., President of The Institute.

The attendance was the largest for some time, the members being most anxious to do honour to the distinguished guest, and also to hear the two discussions which he later gave, one on Institute affairs and one on Bridge Erection.

Mr. Shearwood gave a very complete, though brief, resume of the affairs of The Institute from coast to coast, of its relations with the various Provincial Associations, and outlined several suggestions for the future policy of the profession. At the conclusion he was called upon to answer a number of questions, and several members took part in the discussion. Those present were very glad to have the opportunity of hearing something of their engineering brethren throughout Canada, of whom they would like to see much more than they do.

In Mr. Shearwood's talk on "Bridge Erection" he showed a large number of interesting slides of outstanding bridge work, and explained some of the difficulties encountered, and the ingenious and frequently daring means by which they were overcome. He left his audience with a very high impression of the skill of the engineers and their subordinates who are engaged in this branch of the profession.

In thanking Mr. Shearwood for his address, the Branch chairman, William Casey, M.E.I.C., expressed the pleasure which the Kingston Branch took in meeting the President, and in hearing an address which he was so well qualified to give.

Two new members of the Branch, H. V. Ellegett, S.E.I.C., and J. M. Silliman, A.M.E.I.C., were introduced to the members at the meeting.

London Branch

H. A. McKay, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

No Branch meeting was held in December in view of the fact that it was proposed to hold a meeting on January 4th, 1935, for the purpose of showing the Vickers-Armstrong films which have been going the round of all the Branches of the E.I.C. This date being the earliest available for this purpose.

As these films are of interest to the general public as well as engineers, it was decided to advertise the exhibition in the press and to engage the auditorium of the Technical School. This was done with very gratifying success, about nine hundred persons being present.

Frank Ball, A.M.E.I.C., took the chair and described the various films to be exhibited. The writer does not propose to give a description of them for, presumably, the whole of the members of The Engineering Institute of Canada will have had the opportunity of seeing them.

Mr. Ball called for a vote of thanks to the Vickers-Armstrong firm for their generosity in supplying the films, to Mr. Simpson, head teacher of the electrical department of the Technical School, who operated the lantern, and to Col. Murray Dillon and his Vimy Orchestra who supplied the music during the interludes. These were received and passed with much applause.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

Refractories in Industry

The Ottawa Branch at its luncheon meeting on Thursday, December 6th, 1934, was addressed by F. E. Lathe, of the National Research Council, who spoke on "Refractories in Industry."

Alan K. Hay, A.M.E.I.C., chairman of the Ottawa Branch, presided, and in addition head table guests included: Dr. Charles Camsell, M.E.I.C., J. McLeish, M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., Gordon Gale, M.E.I.C., Dr. G. S. Whitby, H. Frechette, G. D. Mallory, Dr. C. W. Drury, S. F. Kirkpatrick, S. P. Eagleson, and C. McL. Pitts, A.M.E.I.C.

In introducing the subject, Mr. Lathe emphasized the fundamental role played by metals in the history of civilization, particularly in the last one hundred years, and pointed out that metallurgy is wholly dependent upon refractories. Dividing the history of the race into three periods, he showed that during the first or pre-industrial period, extending from the earliest production of brick and pottery to the 15th century, it had been impossible to obtain temperatures above 1,100 degrees C. and demands upon refractories had therefore not been great.

The second period began with the production of cast iron in blast furnaces in Germany and extended to the middle of the 19th century. While cast iron gave an enormous impetus to industry and armament manufacture, fireclay and silica refractories were still ample for the demands made upon them.

The third period was ushered in by Bessemer's remarkable discovery of a cheap method of producing wrought iron and steel. This discovery was followed within twenty-five years by the development of the open-hearth steel furnace and the adoption of basic refractory linings in order to permit the elimination of phosphorous. This led to the use of several new refractories, including dolomite, Austrian magnesite, and the neutral refractory, chromite. Recently Canada has been coming to the front with the production of special basic refractories which are finding a wide market in this field.

The adoption of basic linings for copper converters was cited as an example of a change in refractories bringing about a radical reduction in the cost of a metallurgical operation. A still more recent development is the use of suspended arches for copper reverberatory furnaces, permitting the use of basic brick roofs and wider furnaces and resulting in a greatly increased tonnage per furnace. Basic bottoms for copper anode furnaces also represent an important improvement.

Mr. Lathe outlined the major applications of each of the chief refractories and expressed the opinion that new refractories must soon be developed to meet the demand for higher operating temperatures in metallurgy, and referred to the successful research being carried out by the National Research Council in co-operation with Canadian Refractories, Limited, and the Department of Mines.

At the noon luncheon on December 20th, 1934, T. A. McElhanney, M.E.I.C., Director of the Forest Products Laboratories of Canada, Department of the Interior, spoke upon "Engineering and Economic Aspects of Forest Products Industries." Alan K. Hay, A.M.E.I.C., chairman, presided and head table guests in addition included: Hon. T. G. Murphy, Minister of the Interior; J. B. Hunter, Deputy Minister of Public Works; Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines; Dr. H. M. Tory, President of the National Research Council; C. P. Mahoney, President of Ontario Retail Lumbermen's Association; R. A. Gibson, Assistant Deputy Minister of the Interior; R. L. Sargent, Secretary of Canadian Lumbermen's Association; Group-Captain E. W. Stedman, M.E.I.C., past chairman of the Ottawa Branch; C. Jackson Booth, of the Booth Lumber Company; B. Stuart McKenzie, M.E.I.C., Secretary of the Canadian Engineering Standards Association; and E. H. Finlayson, M.E.I.C., Director of the Dominion Forest Service.

Engineering and Economic Aspects of Forest Products Industries

Pulp and paper manufacture is Canada's largest industry, stated Mr. McElhanney, with the lumber industry, when lumber conversion plants are included, ranking second. Total capital invested in the wood and paper group of industries is nearly one and one-half million dollars.

The forest products industries roughly may be divided into logging operations, sawmill operations, wood conversion plants, and pulp and paper mills.

As a structural material the speaker stated that wood is encountering increasing competition from other materials. This competition has introduced many technical problems into the industries, which have been further accentuated by the development of foreign markets and competition with foreign timbers. For this reason, about twenty years ago the Forest Products Laboratories were established in Canada. Three of these now operate: the main laboratories in Ottawa, a branch laboratory in Vancouver, and the pulp and paper laboratory in Montreal.

Considerable difficulty has been encountered by engineers and architects in specifying timber for structural purposes on account of the lack of standard structural grades for all Canadian species. The Toronto Building Code Committee, who are getting out a new building code, have been paying particular attention to this in co-operation with lumber associations and the Forest Products Laboratories.

About $40,000,000 worth of wood is used for fuel each year in Canada. On the Pacific Coast a special type of burner has been developed for the utilization, for this purpose, of sawdust from sawmill operations. A market has thereby been developed in that area for sawdust which has yielded a return to the mills of about a quarter million dollars per year.

Losses through seasoning of lumber in Canada amount to about 7 per cent of the value of all the lumber produced, which in the total is upwards of $10,000,000 per year. In order to curtail this loss and at the same time provide to the various lumber markets served by Canadian timber, a product suitable for their immediate purpose, it has been necessary for Canada to pay increasing attention to the methods of seasoning lumber.

With particular reference to the pulp and paper field, competition is increasing and the industry is dependent on research to keep its costs down and its quality up and the pulp and paper industry co-operates in the work of the Forest Products Laboratories.

Luncheon to the Hon. Grote Stirling, M.E.I.C.

At the most largely attended luncheon so far of the season, honour was done at a noon luncheon, Thursday, January 10th, 1935, by The Engineering Institute of Canada to the Honourable Grote Stirling, M.E.I.C., in recognition of his elevation to the portfolios of National Defence and of Fisheries. Alan K. Hay, A.M.E.I.C., chairman of the local Branch, who presided at the luncheon, in introducing the Honourable Mr. Stirling, stated that it was the first time that a member of The Institute had become a member of the federal cabinet in Canada.

The Right Honourable R. B. Bennett, prime minister of Canada; the Hon. H. A. Stewart, minister of Public Works; the Hon. R. J. Manion, minister of Railways; the Hon. Alfred Duranleau, minister of Marine; and the Hon. T. G. Murphy, minister of the Interior, fellow members of the Cabinet, were head table guests. In addition, F. P. Shearwood, M.E.I.C., of Montreal, president of The Engineering Institute of Canada, and Fred Newell, M.E.I.C., councillor for Montreal, attended to represent The Institute at large and the Montreal Branch; and other head table guests included: Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines and past president of The Institute; G. J. Desbarats, M.E.I.C., and C. M. Pitts, A.M.E.I.C., councillors for Ottawa of The Institute; Group Captain E. W. Stedman, M.E.I.C., past chairman, Col. L. R. LaFleche, deputy minister of National Defence; and Commander C. P. Edwards, A.M.E.I.C., past councillor for Ottawa for The Institute.

The Honourable Mr. Stirling, after his introduction by the chairman, gave a short address in which he traced down to the present the trend of engineering practice from the days when civil engineering as distinct from military engineering began to receive public recognition in Great Britain. He stated that the engineer had been characterized as a man who ought to be able to tackle anything and was of the opinion that his services were equally important to those of the man who caused two blades of grass to grow where only one had grown before.

In his own two departments there was plenty of scope for the engineers' attainments. He briefly sketched some of the work which they were called upon to do. He paid tribute to The Engineering Institute of Canada as an organization through which the engineer could keep abreast of the times in his own profession, and reminded his hearers that they might quite well exert a greater influence in the community than they do.

G. J. Desbarats, M.E.I.C., expressed the pleasure of the Branch in welcoming a fellow-engineer and congratulated him on his high honour. He briefly sketched the career of the Hon. Mr. Stirling, indicating the very important engineering work for which he was chiefly responsible a few years ago in connection with the irrigation of the Okanagan valley of British Columbia.

F. P. Shearwood, M.E.I.C., president of The Institute, also extended congratulations on behalf of The Institute as a whole. He stated that he felt that the training of the engineer should be of inestimable value in helping to solve some of the problems affecting the social and economic life of the world today. The engineer was able to accomplish much in the way of labour saving devices; he should be able to help in solving some of the problems created by them.

Quebec Branch

Jules Joyal, Secretary-Treasurer.

La Section de Québec a tenu son premier déjeuner-causerie de l'année 1935 au Château Frontenac le 14 janvier; l'invité d'honneur était M. E. D. Gray-Donald, M.S., A.M.E.I.C., surintendant de la Division du Pouvoir pour la Quebec Power Company, qui nous fit une très instructive conférence intitulée "Some Considerations Governing the Undertaking of Hydro-Electric Power Developments."

M. Hector Cimon, M.E.I.C., président de la Section, présenta le conférencier à l'auditoire et M. A. A. MacDiarmid, M.E.I.C., lui proposa un vote de remerciements que l'assistance seconda par de longs et vigoureux applaudissements.

Nous publierons plus tard un extrait de cette conférence.

Saskatchewan Branch

S. Young, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Saskatchewan Branch, Engineering Institute of Canada, was held in the dining room, Parliament Buildings, Regina, on Friday evening, December 21st, 1934, at 7.45 p.m., being preceded by a dinner. A. P. Linton, A.M.E.I.C., occupied the chair.

P. C. Perry, A.M.E.I.C., was duly nominated and elected as Branch representative on The Institute Nominating Committee.

The chairman then introduced the speaker of the evening, M. J. Coldwell, leader of the C.C.F. in Saskatchewan, the subject of his address being "The World Outlook for 1935."

The World Outlook for 1935

Mr. Coldwell stated that travellers returning from abroad, particularly Europe, bring with them a feeling that in the near future we will have either military warfare or social revolution. Consequently he looked forward to the year 1935 with doubt and misgiving.

Two years ago the Ball report emanating from a conference held in Switzerland forecast economic doubt. Immediately following this report there was the economic conference in Great Britain followed by the disarmament conference and more recently the naval conference in Washington. All these conferences have been failures.

Mr. Coldwell remarked that the difficulty faced today is a problem of machine production. Machinery has been made so efficient that the masses are in grave danger of wholesale unemployment. At the present time there are in operation industrial plants using eight men, the whole being equivalent to the former labour of four million men. The speaker stated that not until this problem is solved, namely the proper control of machine production, will we overcome the present depression.

Present production has approximately doubled that of twenty years ago and there being no market for this production we have unemployment with its consequent unrest. In all probability this situation will become more aggravated during the coming year.

In Europe we have recently seen the breakdown of the existing social structures, with the exception of Great Britain, Norway, Sweden and Denmark, where there is comparative tranquillity. Most of the countries of Europe are under one form or other of dictatorship. The danger in particular is that in all those countries where there is economic strife it may develop into military warfare.

The problem then becomes one of control. So far the League of Nations is the most forward step taken internationally. Mr. Coldwell, however, ventured the opinion that the problem must be settled nationally. In the last four years in the city of Regina the collegiate population has increased by eighty per cent with in all probability an actual reduction in the total population of the city. This condition is a direct result of the machine age, the additional students being in the collegiate not entirely from a desire for knowledge but as a direct result of unemployment. Canada is the most highly industrialized nation per capita in the world. These are problems for solution in Canada alone. They cannot be solved by the League of Nations. In general it is in the interests of Canadian social and economic life that the general standard of living be raised.

The problem, being a world problem, is at the root national in character. Consequently any solution, national in character, will be a step forward. To do this use must be made of our democratic institutions to control the cause, namely, the peculiar economic and social condition now existing.

The address was provocative of considerable discussion touching various phases of the subject including the "Douglas Theory." A hearty vote of thanks was tendered the speaker on motion of P. C. Perry and H. S. Carpenter, M.E.I.C.

Vancouver Branch

A. I. E. Gordon, Jr.E.I.C., Secretary-Treasurer.

Annual Meeting

Business and pleasure were combined when the annual meeting of the Vancouver Branch was held on Monday, November 19th, 1934, in the Aztec room of the Hotel Georgia. The meeting was called to order at 8.15 p.m. by P. H. Buchan, A.M.E.I.C., the retiring chairman. Following the reading of the minutes H. B. Muckleston, M.E.I.C., conveyed the thanks of the President and Secretary of the American Society of Civil Engineers and the local Branch to the Executive committee of the Vancouver Branch of The Engineering Institute of Canada for their co-operation and assistance in connection with the Joint Engineering Convention in Vancouver last July.

Elections held at the meeting resulted in the unanimous selection of Jas. Robertson, A.M.E.I.C., and H. N. MacPherson, A.M.E.I.C., as chairman and vice-chairman respectively and G. M. Gilbert, A.M.E.I.C., as secretary-treasurer. New committeemen elected are J. P. MacKenzie, A.M.E.I.C., and P. Sandwell, A.M.E.I.C.

Following presentation of the annual report and financial statement, Mr. Buchan turned over the chair to the new chairman, Mr. Robertson. A vote of thanks to Mr. Buchan was moved by Mr. Muckleston and seconded by Mr. Wheatley. They paid tribute to the energy and ability displayed by Mr. Buchan during his three years as chairman and especially to his ability as a writer and his monumental work in the cause of Institute Development. W. H. Powell, M.E.I.C., rose to express the hope that Mr. Buchan's latest study on the subject of development, which is considered a most able review of the whole situation, would be published in an early issue of The Journal.

At the close of the business session which lasted an hour and an half, refreshments both liquid and solid were enjoyed and the next two hours were devoted to the very excellent programme of songs and entertainment arranged by A. S. Wootton, M.E.I.C., and largely contributed to by local members.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.
E. V. Caton, M.E.I.C., Branch News Editor.

On Friday evening, December 7th, 1934, a joint smoker of the Winnipeg Branch of The Institute, the Manitoba Branch of the Canadian Institute of Mining and Metallurgy, the Association of Professional Engineers of the Province of Manitoba, and junior engineers, was held at the Marlborough hotel.

A station was cut in Shaft No. 13 at the first level, Jorge Koal superintending, chairs and tables were brought along, and the entire shift downed jackhammers and drifters and set about to make the best of the occasion.

Liquid refreshments with exactly the right reactions were served in miniature glass flotation cells, and the solids on concentrating tables, both being transported by white-jacketed conveyors under the supervision of Shift Boss Marcel Bocquin, who later led the singing of "Alouette," after the sand pumps were primed. The solids were quickly reduced by automatic jaw crushers, and after grinding and classifying, were clarified and precipitated in the usual way.

S. E. McColl, A.M.E.I.C., took the part of mine captain and directed an extra shift of entertainers who included Ferris Healey and Trevor Rees in interludes of harmony; Dr. R. M. Cornelius, Lenny Morris and George Seibert, of Blades Fencing Club, in bouts with the foils; Bill Kicenko and Bill Syrnk in bouts of boxing; Jack Trott and Joe Myers in bouts of wrestling; the four O'Tooles in more interludes of harmony; and J. H. Whyard in a burlesque dancing novelty.

The organizer of the party and master of ceremonies was S. E. McColl, A.M.E.I.C.

Employment of Engineers in the United States

An intensive study of the United States census for 1930, made by the American Engineering Council, reveals that in that year there were 225,800 who called themselves engineers, forming 0.46 per cent of the total of 48,830,000 gainfully employed. One engineer was listed for every 500 of population, and one for every 210 persons gainfully employed. The distribution of the engineers by professional classes was as shown in Table I. The fact that the total membership in technical societies was but 115,000 in 1929 indicates that minor technicians were probably included in the census total.

Table I.—*Distribution of Engineers in the United States. By professional classes according to U.S. Census of 1930.*

Class	Number	Per cent
Civil	101,946	45.1
Electrical	57,735	25.6
Mechanical	54,264	24.0
Chemical and Metallurgical	3,434	1.5
Mining	8,408	3.8
	225,787	100.0

Table II.—*Distribution of Engineers by Employment Groups.*

Group	Number	Per cent
Agriculture	625	0.3
Forestry	768	0.3
Extraction Industry	7,730	3.4
Communication	13,211	5.9
Public Utilities	13,700	6.1
Building Industry	16,490	7.3
Transportation	29,349	13.0
Industry and Trade	65,383	28.9
Total of industrial groups	147,256	65.2
Government Service	24,890	11.0
Professional and consulting engineers	53,641	23.8
	225,787	100.0

Although 65 per cent of the engineers were listed as employed by industry and commerce, it should be noted that some industries employed practically no engineering talent. From a study of Table II it appears that the future of the engineering profession is still in the field of private industry, and that a real opportunity lies in the development of backward industries.

A profession-wide survey is now under way by the Bureau of Labour Statistics to determine how the status of engineers has changed since the last Federal Census was taken. This census and survey is being undertaken by Dr. Isador Lubin, Commissioner of Labour Statistics, co-operating with national, state and local engineering societies, through the American Engineering Council.

—*Civil Engineering.*

Analysis of Rigid Frame Concrete Bridges

A third edition of "Analysis of Rigid Frame Concrete Bridges" has been published by the Portland Cement Association, and includes the results of recent studies.

In addition to analysis by moment distribution, a new chart and a new formula are given as basis of a procedure by which moments may be determined quickly without use of frame analysis.

A simple method of correcting moments in frames by allowing for deck curvature is presented, and important structural details used in rigid frame concrete bridges are added. There is also a new convenient method of determining stresses in double-reinforced concrete sections subject to combined bending and axial thrust.

The presentation is brief but clear and complete enough to enable engineers of bridges to analyze rigid frame buildings quickly.

Copies of this 40-page booklet are available by writing to the Portland Cement Association, 33 West Grand Avenue, Chicago, Ill.

Ransomes and Marles Bearing Company of Canada Limited announce a change in name to *R. & M. Bearings Canada Limited.* The Company will be located at the same addresses in Montreal and Toronto.

Preliminary Notice

of Applications for Admission and for Transfer

January 25th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in March, 1935.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

COXWORTH—THOMAS WALKER, of 8045 Chappel Ave., Chicago, Ill., Born at Deloraine, Man., Sept. 2nd, 1903; Educ., B.Sc., Univ. of Man., 1926; 1924-26, chief of party on land and subdivn. surveys, W. & A. Smadbeck Inc., New York, N.Y.; 1926-27, field engr. in charge of land, topographic and subdivn. surveys, for same company; 1927 to date, with McClintock-Marshall Corpn., Chicago, 1927-29, in various capacities in fabricating shop and erecting dept., and 1929 to date, asst. engr. in engrg. and estimating depts., in charge of preparation of estimates and designs, and engaged in a variety of problems of an engrg. nature involving the use of struct'l. steel.

References. E. P. Fetherstonhaugh, J. N. Finlayson, G. H. Herriot, N. M. Hall, A. E. MacDonald.

DUFRESNE—ALPHONSE OLIVIER, of Quebec, Que., Born at Montreal, Que., April 10th, 1890; Educ., B.A.Sc., M.E., Ecole Polytechnique, Montreal, 1911. B.Sc., M.Sc., McGill Univ., 1913; 1907-12 (summers), surveying, munic. engrg., struct'l. steel constrn., geol. surveying; 1911-14, mining engrg., prospecting; 1914-29, inspr. of mines, statistical work, geol. examination, reports on mining properties, and from 1929 to date, Director, Bureau of Mines, Province of Quebec, Quebec, Que.

References. A. B. Normandin, A. Frigon, A. Duperron, H. Cimon, J. P. P. Joncas.

GAGNON—LUDGER, of Quebec, Que., Born at Laprairie, Que., Feb. 22nd, 1903; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1927. S.B., Mass. Inst. Tech., 1928; 1924-25-26 (summers), surveying, Quebec Streams Comm.; 1927 (3 mos.), time and cost keeping, field work, Quinlan, Robertson & Janin; 1928, struct'l. design, Langlais, Ricard & Royer; 1928 to date, asst. city engr., Quebec, Que.

References. H. Cimon, A. B. Normandin, J. Joyal, A. Lariviere, C. H. Boisvert.

GALE—MELVIN LAMBETH, of 12021-97th Street, Edmonton, Alta., Born at De Winton, Alta., Oct. 10th, 1903; Educ., B.Sc. (Civil), Univ. of Alta., 1927; 1922-25 (summers), recorder, rodman, dftsman., Hydrometric Survey, Dept. of the Interior; 1926 (summer), rodman and asst. to dist. engr., Dept. of Highways, Prov. of Alta.; 1927-30, engr., estimator, designer and gen. supervisor for Permanent Construction Co., Edmonton. Making estimates, preparing tenders, carrying out designs in steel, timber and concrete constrn., and acting as gen. supervisor of constrn.; 1930-34, operating under own name as engr. and gen. contractor; Oct. 1934 to date, assessor for the Province of Alberta.

References. R. S. L. Wilson, H. R. Webb, R. M. Dingwall, J. Garrett, R. W. Ross.

HESLOP—WILFRID GIBSON, of 74 Winnipeg Ave., Port Arthur, Ont., Born at Langton, Durham, England, Aug. 28th, 1906; Educ., B.A.Sc., Univ. of Toronto, 1930; 1924-25-26 (summers), chainman, C.N.R., and on mining claims and timber limit surveys; 1927-28-29 (summers), in charge of survey parties; 1930-31, field engr., transmission dept., H.E.P.C., of Ontario; 1931 (June-Sept.), inspr. in Nor. Ont.; 1931-32, location engr. and asst. engr., on Trans-Canada Highways, Dept. of Northern Development; 1932 (July-Dec.), survey work and inspecting for H.E.P.C. of Ontario; 1933 (Oct.-Dec.), demonstrator of surveying, Univ. of Toronto; 1934, res. engr. and inspr., H.E.P.C. of Ontario; 1934 (Oct.-Dec.), demonstrator of surveying, Univ. of Toronto; made many reports re transmission lines for H.E.P.C. of Ontario.

References. W. T. Moodie, J. A. G. White, C. R. Young, C. D. Howe, R. B. Chandler, W. S. Wilson, W. L. Sager.

MacFARLANE—PETER WILLIAM, of 3535 Carleton Rd., Montreal, Que., Born at St. Andrews, N.S., Oct. 31st, 1887; Educ., Nova Scotia Public Schools, 1893-1900; 1902-03, Montreal Locomotive Company, pumps, compressors, dfting table and power house; 1903-04, boiler house, engine room and elect'l. shop, Montreal General Hospital; 1904-05, station operator, Chenneville St., Montreal Light, Heat and Power Cons.; 1905-09, helper to mechanic, Otis-Fensom Elevator Co.; 1909-10, electrn., Windsor Hotel Ltd.; 1910-11. wiring new bldg , Jas. A. Ogilvy Ltd.; 1911-14, service supt., Otis-Fenson Elevator Co.; 1914-18, overseas; 1918-21, service supt., Otis-Fenson Elevator Co.; 1921-22, elevator supt., Darling Bros. Ltd.; 1922-28, reconditioning of property, Windsor Hotel Ltd.; 1928 to date, supt. engr., Dept. of Bldgs. and Grounds, McGill University, Montreal, Que.

References. W. J. Armstrong, F. A. Combe, K. T. Cregeen, F. J. Friedman, H. M. Jaquays, J. A. Kearns, G. K. McDougall, C. M. McKergow.

MARTINEAU—JOSEPH OMER, of Quebec, Que., Born at Charlesbourg, Que., Aug. 7th, 1893; Educ., B.Sc., Queen's Univ., 1915; 1912-14 (summers), Federal Public Works; 1916 to date, with Dept. of Roads, Prov. of Quebec, from 1922 to date, as asst. chief engr.

References. J. A. Lefebvre, J. O. Montreuil, A. B. Normandin, A. Lariviere, J. E. Roy, O. Desjardins.

MATTHEWS—SAMUEL, of 704 Saskatchewan Crescent East, Saskatoon, Sask., Born in Aberdeenshire, Scotland, Sept. 21st, 1893; Educ., B.Sc. (Ceramic Engrg.), Univ. of Sask., 1928; Summer work: 1924-25, Refractories (Manufacture); 1926, terra cotta manufacture; 1927, research on Sask. Ball clays; 1927-28, part time demonstrator in ceramics; 1928-29, ceramic engr. for the Citadel Brick Co. Ltd., Quebec, Que. Solving drying problems and improving quality of ware. During winter months engaged in research work at Univ. of Sask.; 1929 to date, ceramic engr. for the Dominion Fire Brick and Clay Products Ltd., Moose Jaw, Sask. Supervn. of clay pits, refractory mixtures, mfg. and listing of products, plant constrn. Also in charge of research work carried on during winter months.

References C. J. Mackenzie, W. G. Worcester, A. R. Spencer, J. J. White, H. B. Brehaut.

OVERALL—CYRIL ARTHUR GOODWIN, of 103 Epworth Circle, Niagara Falls, Ont., Born at Walthamstowe, Essex, England, May 7th, 1905; Educ., B.Sc. (Chem.), Tri-State Coll., Angola, Indiana, 1932; R.P.E. Ont.; 1919-21, mach. helper, Herbert Morris Crane and Hoist Co., Niagara Falls, Ont.; 1923-25, jr. dftsman., American Cyanamid Co., Niagara Falls; 1925-27, mill dftsman. for plant with 600 employees, Kimberley-Clark Corpn., Niagara Falls, N.Y.; 1927-30, designing dftsman., Spruce Falls Power and Paper Co., Kapuskasing, Ont. (also checker); 1932-33, designing dftsman. and engr., American Cyanamid Co., Niagara Falls, Ont.; 1933-34, Ontario Training College for Technical Teachers. Granted vocational cert. qualified for dfting. instructor (elem. mach. design, strength of materials, etc.); 1934 to date, designing dftsman., checker and engr., American Cyanamid Co., Niagara Falls, Ont. (Jan. 1st, 1935, name changed to North American Cyanamid Co. Ltd.).

References: C. W. Boast, E. D. W. Courtice, S. R. Frost, H. L. Bucke, W. S. Orr, F. L. Haviland, P. A. Dewey, A. W. F. McQueen.

PARADIS—ALPHONSE, of Quebec, Que., Born at La Patrie, Que., Aug. 16th, 1883; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1912; 1912-14, Laval Univ., teaching; 1914 to date, with Dept. of Highways, Prov. of Quebec, as follows: 1914-15, inspr., 1915-18, engr. in charge of Macadam constrn.; 1918-32, dist. engr., 1932 to date, chief engr.

References: A. B. Normandin. A. Amos, L. Beaudry, J. L. Bizier, O. Desjardins, J. P. Joncas, A. Lariviere, P. Methe.

SCRYMGEOUR—DONALD STUART, of London, Ont., Born at Winnington, Cheshire, England, May 1st, 1891; Educ., 1913-17, Royal Technical Institute, Salford, England. While there obtained City and Guilds of London Bronze Medal—Struct'l. Engrg. 1917; 1911-15, ap'ticeship with Skipwith, Jones & Lomax Ltd., Struct'l. Engrs., Manchester, England; 1915-18, with Heenan & Froude Ltd., Struct'l. Engrs., Manchester; 1918-20, chief dftsman. and steelwork inspr. and progress engr., W. Alban Richards Ltd., Gen. Contractors and Engrs.. London, England; 1920-23, asst. chief dftsman. and estimator, Widnes Foundry Co. Ltd., (bridge dept.), Widnes, Lancs., England; 1923-24, chief dftsman. and estimator of city office, E. C. & J. Keay Ltd., Constrn. Engrs., Birmingham; 1924-25, leading dftsman., Horseley Bridge and Engrg. Co. Ltd., Dudley Port, Staffs., England; 1925-28, leading dftsman., Rendel, Palmer & Tritton, London, England, consltg. engrs. to Indian Office, Indian State and other rlys.; 1928, steelwork checker, Hamilton Bridge Co. Ltd.; 1928 to date, chief dftsman. London Structural Steel Co. Ltd., London, Ont.

References: H. A. McKay, W. M. Veitch, J. R. Rostron, W. C. Miller, J. A. Vance.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BENNETT—HARRY FREDERICK, of Sault Ste. Marie, Ont., Born at Saint John, N.B., May 6th, 1888; Educ.. B.Sc. (C.E.), Univ. of N.B., 1908; with Dept. of Public Works of Canada as follows: 1908-12, asst. engr., Saint John, N.B., 1924-30, senior asst. engr., Halifax, N.S., and 1930 to date, district engr., Sault Ste. Marie District. (*St. 1907, Jr. 1914, A.M. 1920.*)

References: K. M. Cameron, R. deB. Corriveau, H. J. Lamb, G. Stead, F. G. Goodspeed, O. S. Cox.

LINTON—ADAM PEARCE, of Regina, Sask., Born at New Hamburg, Ont., July 4th, 1884; Educ., B.A.Sc., Univ. of Toronto, 1908; 1906-07, dftsman., Hamilton Bridge Works; 1908-11, dftsman., Dominion Bridge Co.; 1911-12, St. Lawrence Bridge Co., on design of Quebec Bridge; 1912-15, chief bridge engr., Dept. of Highways, Govt. of Saskatchewan; 1915-19, overseas, Can. Rly. Troops. Commanded First Bridging Co. in Palestine. Major. Mentioned in despatches and decorated, O.B.E.; 1919 to date, chief bridge engr., Dept. of Highways, Govt. of Sask., since 1912 (except 1915-19), responsible for design, constrn. and mtce. of all highway bridges in Saskatchewan. (*St. 1908, A.M. 1913.*)

References: H. S. Carpenter, H. R. MacKenzie, D. A. R. McCannel, S. Young, C. J. Mackenzie.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CARRUTHERS—CLARENCE D., of 253 Castlefield Ave., Toronto, Ont., Born at Millbrook, Ont., Oct. 10th, 1901; Educ., B.A.Sc., Univ. of Toronto, 1927; 1920-21, jr. dftsman., B. N. Brack, Arch'ts.; 1921-22, jr. clerk of work, Sunnyside Development, Toronto Harbour Commn.; 1923, dftsman., Truscon Steel Co.; Summers 1925-26-27, in charge of small party, Geodetic Survey of Canada, mapping of City of London; 1927 to date, designer, dftsman., with Gordon L. Wallace, M.E.I.C., Consltg. Engr., Toronto, Ont. (*St. 1927, Jr. 1929.*)

References: G. L. Wallace, C. R. Young, F. P. Steers, L. A. Lee, J. Hole.

DAVIDSON—JOHN KNOX, of Buckingham, Que., Born at Stranraer, Scotland, Feb. 1st, 1905; Educ., B.Sc., Univ. of St. Andrews, Scotland, 1926; Passed exams. for A.M. Inst. C.E., London, England, 1928. Elected A.M.I.C.E., 1931; 1926-27, asst. engr. and 1927-28, asst. chief engr., Corpn. Waterworks, Dundee, Scotland; 1928 (May-Nov.), asst. field engr., Sir Robert McAlpine and Sons, Contractors, London, England; 1929 (Jan.-Apr.), asst. to Robert Gibson, consltg. engr., Dundee; 1929-30, detailer, designer and field engr., Dominion Bridge Co. Ltd., Montreal; 1930-31, res. engr. in charge of constrn. of rapid sand filtration plant for City of Brantford, Ont.; May 1932 to date, chief engr., Electric Reduction Co. Ltd., Buckingham, Que., in charge of gen. plant operation and design and constrn. of plant developments. (*Jr. 1930.*)

References: L. H. Burket, W. S. Lea, F. P. Adams, C. A. Waterous.

GRAHAM—WALTER WHITE, of 5746 Charlemagne Ave., Montreal, Que., Born at Glasgow, Scotland, Aug. 29th, 1901; Educ., B.Sc., McGill Univ., 1925; Summers: 1922, rodman on rly. constrn.; 1923, concrete inspr., Steel Co. of Canada, Montreal; on installn. work, La Gabelle development, Shaw. Water and Power Co.; 1925-28, elect'l. and hydro-electric design, Power Engrg. Co.; 1928 to date, elect'l. designer, Shawinigan Engineering Co., Montreal, Que., on design and installn. of equipment, etc., particularly in connection with Rapide Blanc development. (*St. 1923, Jr. 1928.*)

References: S. C. Hill, A. B. Rogers, R. E. Heartz, A. S. Poe, J. A. McCrory.

LAIDLAW—DOUGLAS STAUNTON, of Toronto, Ont., Born at Toronto, Sept. 23rd, 1905; Educ., B.A.Sc., Univ. of Toronto, 1928; 1928-29, inspr., testing lab. and dftsman., hydraulic dept., H.E.P.C. of Ont.; 1930-32, designing dftsman., DeHueck and Mattice, United Engrs. and Constructors and Beauharnois Constrn. Co., Montreal; 1932-34, asst. to John B. Laidlaw, then chief agent for Canada of the Norwich Union Life Assurance Society, supplemented by private practice as a struct'l. engr.; at present, private practice as struct'l. engr. in partnership with Catto and Catto, Architects, Toronto, Ont. (*Jr. 1930.*)

References: A. H. Harkness, T. H. Hogg, C. H. Mitchell, J. M. Oxley, J. F. Plow, M. V. Sauer, C. R. Young, R. B. Young.

LOVETT—PERCY ARTHUR, of 107 Morris St., Halifax, N.S., Born at Liverpool, N.S., April 17th, 1903; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1928; 1927 (summer), C.G.E., Peterborough, Ont.; 1928, asst. on N.S. Advisory Board of Fuel Investigation; 1928-30, graduate ap'tice, Canadian Westinghouse Co. Ltd., Hamilton, Ont.; 1930-33, asst. engr., Maritime Tel. and Tel. Co.; 1933, associated with J. R. Kaye, A.M.E.I.C., on consltg., supervision and design work; 1933 to date, consltg. engr. with Engineering Service Co. Ltd., consltg., supervn. and design work. (*St. 1928, Jr. 1931.*)

References: I. P. MacNab, J. R. Kaye, W. A. Winfield, F. R. Faulkner, F. A. Bowman.

FOR TRANSFER FROM THE CLASS OF STUDENT

ARMSTRONG—OWEN FRED CALDER, of 4594 Decarie Blvd., Montreal, Que., Born at Round Hill, N.S., Jan. 26th, 1901; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1928; 1925 (summer), highway constrn.; 1927 (summer), bldg. constrn.; With Bell Telephone Co. of Canada as follows: 1928-29, student engr.; 1929-31, asst. to divn. traffic engr.; 1931-33, asst. to district traffic supt.; 1933 to date, asst. to gen. employment supervisor, Gen. Traffic Dept. (*St. 1926.*)

References: C. L. Brooks, E. Baty, A. M. Robertson, H. E. McCrudden, F. W. Angus.

COSTIGAN—JAMES PERCIVAL McDOUGALL, of 494 Grosvenor Ave., Westmount, Que., Born at Westmount, Oct. 15th, 1904; Educ., B.Sc., McGill Univ., 1926; With Shawinigan Water and Power Company as follows: Summer 1924, La Gabelle development; 1926-28, power ap'ticeship course; 1928-33, design and supervn. of constrn. of distribution lines, transmission lines, and substations; 1933 to date, design and supervn. of mech'l. and elect'l. equipment of industrial bldgs., T. Pringle & Son Ltd., Industrial Designing and Supervising Engrs., Montreal, Que. (*St. 1925.*)

References: C. V. Christie, R. H. Mather, G. M. Wynn, J. H. Fregeau, G. R. Hale, A. C. Abbott.

GREENWOOD—FREDERICK DWYER, of Timmins, Ont., Born at New Liskeard, Ont., July 14th, 1907; Educ., B.Sc., Queen's Univ., 1931; 1298 (summer), township survey, Nor. Ont.; With Ford Company of Canada as follows: 1929-30 (summers), tool room; 1931 (summer), millwright dept.; 1931-32, designer, tool design dept.; 1932-33, engrg., engrg. dept.; 1933-34, stationary engr., Vipond Mines; Oct. 1934 to date, designer, Hollinger Cons. Gold Mines, Timmins, Ont. (*St. 1928.*)

References: J. E. Porter, W. A. Dawson, L. T. Rutledge, L. M. Arkley, V. W. MacIsaac.

STRIOWSKI—JOHN BENJAMIN, of 230 Arlington St., Winnipeg, Man., Born at Winnipeg, April 11th, 1907; Educ., B.Sc., Univ. of Man., 1929. (Thesis still to be completed for M.Sc.); 1926-27-28 (summers), surveys and constrn. of branch lines, rodman and instr'man., C.N.R.; 1929 (summer), and 1930-31, Northwestern Power Co. Ltd., Winnipeg, dftng., design and detailing of reinforced concrete structures, Seven Sisters hydro-electric power development; 1929-30, demonstrator in civil engrg., Univ. of Man.; 1931-33 (intermittently), with Dept. of Northern Development, Kenora, Ont., topog'r., levelman, transitman on location surveys, also res. engr. on constrn. Trans-Canada Highway. (*St. 1927.*)

References: J. N. Finlayson, A. E. MacDonald, G. H. Herriot, N. M. Hall.

WICKWIRE—LAWRENCE DAVID, of Liverpool, N.S., Born at Milford, N.S., Aug. 24th, 1907; Educ., B.Sc., N.S. Tech. Coll., 1933; 1925-26, lumber checker, elect'ns. helper; 1933 to date, engrg. dftsman., Mersey Paper Co., Liverpool, N.S. (*St. 1933.*)

References: J. H. M. Jones, C. H. L. Jones, F. R. Faulkner, R. L. Seaborne, W. P. Copp.

Worker Unrest in Construction

For three years construction employment has been low. It is still low, and especially in heavy construction a good job ought to be welcome. But it does not seem to be welcome if the strike of a group of workers on the Midtown tunnel in New York is any criterion. The tunnel workers have good hours and wages—PWA hours and wages, in fact,—yet they strike. Wages and working conditions evidently are not the issue.

The contractor says that the strike began without notice or demand and pickets who walk before the shaft carrying "Unfair" signs say that they do not know what union is striking or why. A union representative says that the strike is a protest against the employment of non-union labourers on the job. So the issue seems to be compulsory unionization, with the usual symptoms of regimentation by organizers and threats of a sympathetic general strike.

It is strange that workers strike when they have just found a good job and have no complaint against hours, wages or treatment.

Out of this confusing situation two facts emerge prominently. One is that the extensive new rights granted to labour by the Recovery Act do not include the right to compulsory unionization or the right to deprive non-union men of work. The second is that the course of the NRA officials in dealing with labour relations has been such as to mislead labour into believing that it was given this right and is entitled to fight for it. A third fact ought to be noted with these—namely, that in many of the recent strikes the majority of workers desired to stay at work but were either tricked or intimidated by the minority.

To bring this strike fever to an end is as important to the workers as to industry and consumer. It is at present the most critical essential to continuation of the recovery process. Construction in particular ought to guard itself against the strike habit so that it may continue to perform its essential service of stimulating general recovery of business and industry.

If the present labour difficulties are to be ended, it will come about through steady and sensible firmness on the part of the sound majority of labour, working in harmony with the employers who also in the large majority are seeking for stable and mutually advantageous relations with their employees.—*Engineering News-Record.*

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

DRAUGHTSMAN, with pulp or paper mill experience for work in Northern Quebec. Give full information regarding age, education, experience, etc. in first letter to Box No. 1092-V.

RADIO ENGINEER, under 35 years of age wanted for responsible position in production department of large manufacturing concern. Must be experienced in transformer winding, design of test apparatus, supervision of test procedure and quality control. Apply giving references, education, experience, age and salary expected to Box No. 1100-V.

PURCHASING ENGINEER, man with broad commercial and business experience for purchasing department of large manufacturing concern. Technical experience required. In reply please outline in detail complete experience. Apply to Box No. 1102-V.

Situations Wanted

ESTABLISHED SALES ENGINEER. Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., Jun. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

Employment Activities

The attention of members is called to the reports of The Institute Committee on Unemployment and of the Employment Service Bureau which appear on pages 90 and 91 of the February, 1935, issue of The Journal.

These reports show considerably improved conditions over those reported during the past few years.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box. No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box. No. 651-W.

Situations Wanted

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting, concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper millwork, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, N.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.Sc., Queen's '33 Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Write and speak both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211 W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

COMBUSTION ENGINEER, A.M.E.I.C., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

MECHANICAL ENGINEER, B.Sc. McGill. Experienced as supt. of plant manufacturing home appliances—purchasing of supplies and equipment of technical nature. Plant engineer of works for manufacture of railway equipment and of copper and brass rolling mill and seamless brass and copper tube mill and brass cartridge cases. Designing engineer on special machinery, maintenance engineer, plant layouts. Apply to Box No. 1241-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet and tissues. Apply to Box No. 1246-W.

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THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public"

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Testing and Research for the Hydro-Electric Power Commission of Ontario

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Paper presented before the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ontario, February 8th, 1935.

SUMMARY.—The work of the Commission's department of testing inspection and research is described, including the inspection and testing of materials and equipment for the use of the Commission, the investigation of technical problems arising in the Commission's work and the approval of electrical equipment for use under the Canadian Electrical Code.

Practically all large electrical power companies have laboratories which carry on testing and research in varying degrees depending upon the size of the organization. These departments have been established to supply a variety of services, among which are the following:

(*a*) The determination of quality of material and equipment submitted for purchase, and its compliance with guarantees.

(*b*) The application of special knowledge in physics, mathematics and chemistry to practical problems encountered in construction and operation.

(*c*) The control of quality of material and equipment in service by periodic tests and inspections which will detect signs of failure.

(*d*) The furnishing of technical information based on special studies within the capabilities of the equipment and staff.

These demands imply the existence of testing equipment and of a staff trained in test methods and the handling of instruments, and permitted to devote their energies to more specialized and scientific studies than those engineers wholly engaged in the problems of design, construction and operation of power systems. The logical and economical method of providing these services is to centralize staff and equipment in a single department. Hence the existence of testing and research laboratories in power companies. These departments have almost without exception dated from the beginning of the organizations they serve, and their evolution has kept pace with the growth of the parent organizations.

The Testing and Research Laboratories of the Commission developed in a manner somewhat similar to that just outlined. Shortly after the Commission completed its original construction programme and began supplying power, equipment for testing lamps was installed in the Strachan avenue terminal station. This was in 1911. The intention of the Commission was to assist the municipalities in the purchasing of lamps, and this activity has continued to be an important function of the department. From this beginning the department has grown and now occupies about 29,000 square feet in the service building on Strachan avenue. A wide range of equipment is available for making electrical, physical, chemical, metallurgical and photometric tests. Many parts of this have been developed and constructed in the laboratory. The work of the department is not confined to the laboratory, but the duties of the staff take them on occasions to all parts of the systems.

The first duty of the department is to furnish a testing and inspection service to the other departments of the Commission and to the municipalities. The Commission has always followed the general policy of making important purchases in accordance with strict specifications, and it is the task of the laboratory to determine whether or not material and equipment submitted for purchase conforms with the requirements of the specifications. The services of the laboratory are also demanded in connection with the maintenance of equipment and the operation of the systems, and a large portion of the routine testing is at present concerned with operating problems.

During periods of active construction, the work naturally increases in volume. This portion of it, however, varies from year to year depending upon the amount of construction work under way. The portion arising in operating problems, however, is of a more permanent character and shows a steady growth from year to year. This is fortunate since it enables the department to retain a minimum permanent staff thoroughly conversant with the organization and its methods of operation. The value of this is self-evident.

The research work carried on has a distinctly practical aspect, since it is concerned of necessity with problems which arise in the construction and operation of the Commission's systems. Problems of a purely scientific nature are left to universities and scientific institutions. Even with these limitations, however, its scope is sufficient to embrace a wide field in engineering theory and practice and in the properties of materials.

Demands are continually being made upon the department to furnish information of a scientific nature, and it thus serves as a clearing house for the different departments in the interchange of technical information beyond the scope of ordinary requirements.

The functions of the department may thus be briefly stated by saying that it is required to assist the Commission in securing material and equipment of good quality, in maintaining this equipment in good condition after it has been installed, and in furnishing a variety of services of a specialized character. At the same time, it has an executive standing based upon the policy of the Commission in co-ordinating activities connected with testing and research within one department. Thus the testing and inspection of materials is carried on only by the Laboratories, and the research work carried on in the Commission is under the direction of the department.

Fig. 1—Service Building, Strachan Avenue, Toronto.

The Approvals Laboratory

The department carries on another important function not directly connected with the construction and operating problems of the Commission. This is the approval testing of electrical equipment which is complementary to the inspection of electric wiring and installations carried on by the Commission under Section 80 of the Power Commission Act. No attempt will be made here to describe this work in detail. It involves laboratory testing, inspection in factories, and a great deal of field work in checking the quality of electrical appliances sold to the public. It was undertaken by the Commission as a matter of necessity about sixteen years ago. The regulations of the Commission required that such materials and equipment should conform to a minimum safety standard and this involved the testing of the equipment. The only organization then furnishing a testing service of this kind was Underwriters' Laboratories of Chicago, and since its approval was not obligatory in the United States much equipment of American origin offered for sale in Ontario did not bear its approval. The Commission accordingly decided to make use of its existing laboratory for the purpose of controlling the quality of this equipment. The work was carried on essentially in the same manner as by Underwriters' Laboratories, and its effects were soon apparent in the improvement in safety characteristics of equipment offered to the public of Ontario. The commencement of the Commission's activity in this connection synchronized with another movement which was destined to prove of great importance to the electrical industry of Canada. The demand for a uniform set of rules governing electrical wiring and installations which would be acceptable all over Canada resulted in the organization of a committee under the auspices of the Canadian Engineering Standards Association—then recently formed—to prepare such a set of rules. This resulted in 1927 in the appearance of the first edition of the Canadian Electrical Code. Following this legislation was passed in all provinces of Canada providing for provincial control of the inspection of electrical installations and in many cases also the control of the sale of appliances to the public. The last province to enact such legislation was Prince Edward Island in 1932. These regulations involved the approval of appliances and the Code accordingly defined "approval" and recognized Underwriters' Laboratories, the Laboratories of the Hydro-Electric Power Commission, and a Dominion government laboratory when such should be established. The adoption of the Canadian Electrical Code produced an increased demand upon the services of the Commission's Approvals Laboratory, and following the withdrawal in 1932 by Underwriters' Laboratories of its electrical testing service from Canada all Canadian manufacturers of electrical equipment since have made use of the Commission's service. The National Research Council has established research laboratories in Ottawa and has been requested by various provincial departments to set up safety standards and to approve apparatus. The question of the future of the electrical approval testing work is now under discussion between the Council and the Commission.

The procedure followed by a manufacturer in obtaining approval involves the submission of representative samples of his product to the laboratory, where they are examined to determine compliance with specifications in which minimum safety requirements are set forth. When the laboratory is satisfied that the equipment conforms with the specifications, a report describing the equipment and the tests, and recommending approval, is prepared and circulated to a committee of about thirty members located in all parts of the country and including electrical inspectors, underwriters, contractors, fire marshals, engineers and others interested in the enforcement of safety regulations and competent to pass upon the reports. Upon the acceptance of the recommendations of the laboratory by the committee, the equipment is listed as approved. The manufacturer then signs an agreement with the laboratory whereby he undertakes to manufacture the product approved in duplicate of the sample submitted, and to permit the laboratory to make periodic inspections in his factory in order to determine whether or not this is being done. The laboratory publishes a list of approved equipment and circulates it to all inspection offices in the country and to officials connected with the enforcement of sales control regulations. The specifications governing the tests were formerly prepared by the laboratory in co-operation with the manufacturers, but this work is now being done under the auspices of the Canadian Engineering Standards Association by committees composed of laboratory representatives, manufacturers and others. The Canadian Engineering Standards Association issues the specifications, which are then adopted by the laboratory and enforced in the same way as the provisions of the installation rules of the Canadian Electrical Code. The cost of the approval service is borne by the manufacturers in the payment of fees both for approval testing and for periodic re-examination. Approved equipment may be identified either by labels supplied by the laboratory or by reference to the approved list of equipment.

This brief summary describes only the principal features of this work, which entails a vast amount of detail both in testing and inspection, and in the keeping of records. The last edition of the list of approved equipment contains the names of fourteen hundred and forty-three manufacturers located in Canada, the United States, Europe and Japan.

Testing and Inspection

The nature of the testing and inspection work has been indicated above, and a large portion of it is connected with routine operations and special problems encountered in maintenance and operation. During the fiscal year ending October 31st, 1934, over forty-six thousand tests were made in the laboratories including electrical, chemical, physical, mechanical and photometric. During the same period the factory inspection included steel for all purposes, transmission line conductors, turbines, generators, transformers, circuit breakers, and other equipment. The examples given below have been chosen as typical of

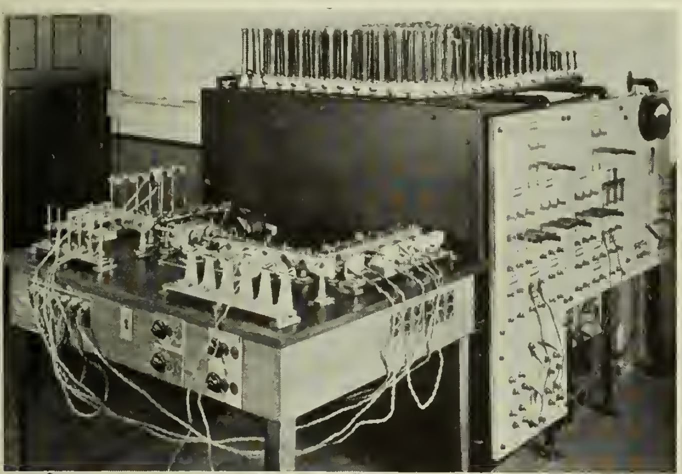

Fig. 2—Machine for Making Endurance Tests on Sockets, Switches, etc.

the method of carrying on the work of testing and inspection and will indicate its extent. It should be pointed out that an effort is continually being made in this work to maintain a proper economic balance, and that the completeness of the inspection depends upon the size of the equipment or of the development, and the decision to inspect a particular item is reached after consultation with the Engineering Department having due regard to the cost of the equipment, its importance in the scheme of operation, and the consequence of its failure in service. Accordingly, it is often necessary to inspect a very small and apparently insignificant item of equipment, because its failure in service might involve the shutting down of a huge generator for a considerable period of time, and the consequent loss of revenue to the Commission or the interruption of service to a large section of the community. This, of course, must be avoided as far as humanly possible. On the other hand, relatively large items are sometimes accepted without complete inspection. This acceptance is based on the department's knowledge of conditions in the shops as well as upon other factors, such as the exigencies of the construction programme.

In the construction of power developments both mechanical and electrical equipment is required in large quantities.

The department first assists the Engineering Department in the preparation of specifications, particularly in matters involving the properties of materials or characteristics of equipment. The fabrication of the equipment is followed as closely as possible in the shop and when the development is large enough to warrant it, inspectors are stationed in the shops.

Turbines and generators require close and detailed inspection covering all phases of manufacture and erection from the time the castings and forgings are made until the machines are finally assembled and ready for service. This work calls for the services of experts thoroughly trained in the actual inspection and intimately acquainted with the conditions under which the machines will be used.

An inspector is present to witness the behaviour of the metal during the pouring of castings and the forging of ingots for runners, frames, bearing brackets, shafts and other large sections used in powerhouse units. Later, these are examined in the "green" condition and also after annealing and heat treating to detect cracks, slag holes and similar defects. Physical tests are made in the manufacturers' shops and samples of the metal are given microscopic examinations at the laboratory to determine the character of the crystal structure. Important machining and welding operations are carefully scrutinized and rigid checks on shaft dimensions and alignment are required before release is granted for shipment to the field.

Circuit breakers and transformers are similarly inspected in the shop to ensure that they are electrically and mechanically perfect. This involves inspection of tank welds, checking of dimensions, dielectric tests and frequently the determination of speed of operation.

The final acceptance of a generating unit is based upon tests made after erection. A field acceptance test on a large unit is an engineering project of some difficulty and of great importance, requiring a staff of engineers and assistants and often consuming several weeks. It includes the determination of turbine and generator efficiency and of temperature rise under load; the application of specified dielectric tests to the generator insulation; the observation of performance under overspeed and sudden short circuit conditions; and the application of many other tests designed to reveal any defects still existing in the equipment.

The procedure of the Commission in inspecting concrete has been described in a number of papers by members of the laboratory staff. It is in outline as follows: When a power development is projected the laboratory is instructed to recommend a suitable source of building materials. This involves a search in the neighbourhood of the development and a survey of available deposits of sand and gravel. Test pits are sunk, samples secured and tested at the laboratory. When a suitable source has been acquired, preliminary proportions for the concrete are set by laboratory tests and an inspector trained in laboratory methods is stationed in the field and provided with a field laboratory and the necessary testing equipment if the job

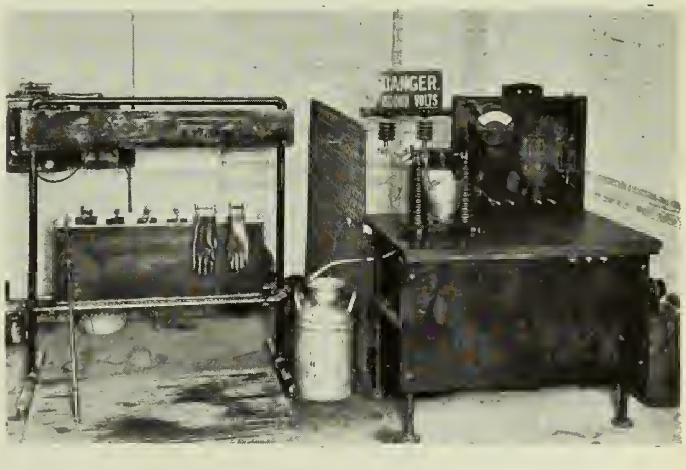

Fig. 3—Equipment for Testing Rubber Gloves and Transformer Oils.

is large enough to warrant this expense. The inspector follows all the operations of mixing and placing the concrete and of testing its quality from time to time in order to obtain compliance with the strength requirements set by the design department.

Inspection of concrete does not cease with the completion of a new structure. All the concrete structures of the Commission are inspected by an expert from the laboratory every two years and a complete record of these inspections is embodied in reports in which necessary repairs are recommended. The Commission's investment in concrete structures is many millions of dollars, and this inspection is considered essential to the proper maintenance of these structures.

The service rendered by the laboratory in controlling the quality of materials in use is well illustrated in the cases of linemen's gloves, oil, and paint.

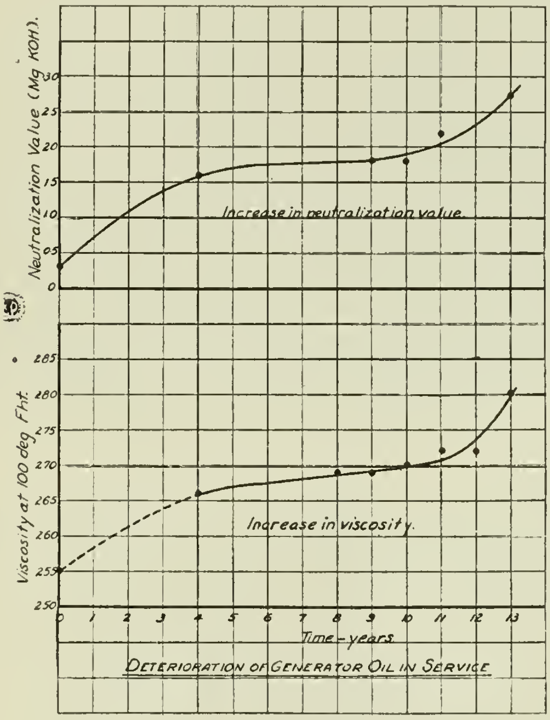

Fig. 4—Deterioration of Oils in Service.

Gloves are purchased under rigid specification and every glove passes through the laboratory not only at the time of its purchase but periodically thereafter, in accordance with a programme determined by the Accident Prevention Department. New gloves are examined and accepted only on the basis of compliance with the specifications. They are shipped from the laboratory after test in special containers bearing laboratory labels. Periodic retests are not as elaborate as the acceptance tests; they involve the application of high voltage (10,000 volts for one minute) and a visual examination. Frequently a glove is rejected even though it passes the high voltage retest, because of mechanical defects which in the judgment of the inspector would involve a hazard to the user and probable failure in the near future.

Oil is used in transformers and circuit breakers, both as an insulating medium and a cooling agent. Its insulating properties are seriously affected by even slight traces of moisture and other impurities. It is also affected in a way not thoroughly understood by high temperatures and by electric stress. It is of extreme importance that its quality be maintained and that evidence of failure be detected before it has proceeded far enough to endanger the equipment. The Commission endeavours to maintain the quality of oil by making monthly dielectric tests on samples carefully selected from all high tension transformers and circuit breakers. The laboratory makes over five thousand tests a year. If moisture or impurities are detected the equipment from which the sample was taken is removed from service and the oil filtered. Supplementing these monthly dielectric tests, a survey of the oils in all high tension transformers is made every three or four years. Samples are tested for acidity, sludge-forming properties and resistance to emulsification, and recommendations made to the Operating Department as to the necessary treatment to restore the oil to operating condition. This procedure is yielding a great deal of information not only on the properties of insulating oil but on the changes which take place in it when subject to operating conditions in transformers and circuit breakers. This subject is very complex and is being given international attention through the efforts of standardizing bodies, such as the International Electrotechnical Commission and the American Society for Testing Materials, in which power companies and purchasers of oil are co-operating in the endeavour to devise reliable tests which may be used to form the basis of specifications covering these qualities. The Commission's laboratory is assisting in this work and as a result of its contacts with these organizations, benefits by the experience of a very large group of oil producers and users.

Lubricating oil used in turbines and generators is subjected to a similar system of control. It is purchased under specifications prepared by the Engineering and Laboratory Departments in co-operation. Its quality in service is determined by annual check tests. Careful attention is paid to acidity, viscosity, flash and fire points and resistance to emulsification. These periodic tests indicate the chemical changes, if any, which will result in deterioration. Figure 4 shows the result of such measurements extending over a period of years and indicates clearly the deterioration of the oil. The determination of the point at which it must be removed from service or treated is a matter of some importance, and recommendations from the laboratory to the Operating Department are based upon these tests.

Paint is an important material used in practically all of the Commission's structures. There is probably no material to which the saying "you get what you pay for" applies with greater force. The laboratory has been studying paints for over fifteen years and when the work was undertaken first there was no method whereby paints submitted for purchase could be quickly compared and a decision formed as to the most desirable. The method then commonly used was to expose samples to conditions duplicating as nearly as possible those which the paint

Fig. 5—Weather Meter for Paint Testing.

would encounter in service. The first step therefore was to set up a rack on the laboratory roof on which were mounted slabs of steel, concrete or wood, painted with samples of the products of various manufacturers. The exposure tests were supplemented by chemical analysis of the paints. Proceeding in this way it was found possible to obtain comparative information on the products of various manufacturers and a system of purchasing paints was worked out in which the laboratory co-operated with the Purchasing Department and with the field. In ordering paints under this system the manufacturer's name is not specified, only the application—for example, concrete floors, steel penstocks, transmission towers, etc. From a list supplied by the laboratory the Purchasing Department chooses satisfactory sources of supply. A committee containing representatives of the Laboratory, Purchasing, Engineering and Operating Departments direct this work in a general way, correlating laboratory tests and field experience. Progress in test methods made within recent years permits obtaining a quick appraisal of the relative merits of various paints for any particular service by means of the weatherometer, a device capable of applying an accelerated life test. The co-operation of the manufacturers of paint has been very helpful in all of this work.

The examples given above have been chosen with a view to illustrating the methods employed by the Commission in determining and controlling the quality of materials. These methods are being extended as rapidly as possible to new materials and they are indicative of the general trend in engineering practice, perhaps insufficiently realized but nevertheless of tremendous importance, viz., the increasing use of laboratory methods. The success of these methods depends, of course, on the invention of tests which will give reliable information concerning the qualities of materials. Not only must these tests be reliable but they must yield information quickly. Accelerated life tests are of particular importance. The development of tests and test methods is a matter for research supplemented by field experience and is work which makes the greatest demands both upon knowledge of the properties of materials and skill in testing technique, and can be carried out successfully only by the co-operative effort of a large group. A survey of the proceedings of organizations such as the American Society for Testing Materials or the International Electrotechnical Commission, as well as the national standardizing institutions in different countries, will indicate the extent of this co-operative effort and the rapid advance which is being made in this field.

Visual inspections by "trial and error" methods were never satisfactory even to the intensely practical man, and are gradually being supplanted as laboratory methods are developed and as confidence is built up in the efficacy of these methods.

Research

The practical nature of the research work carried on in the Commission has been indicated earlier in this paper. The examples which follow have been chosen to illustrate the method of attacking these problems and the limits within which the Commission confines itself. The necessity for close co-operation between laboratory and field staffs is as great as in the case of routine testing and this was taken into account in devising the method of carrying on this work which is now in operation.

A research committee composed of five department heads gives general direction to investigational work. It appoints sub-committees to undertake particular investigations and gives general guidance to their efforts. Each sub-committee contains representatives of the laboratory and of such other departments as may be interested in or capable of assisting the research in question. At the present time ten sub-committees are active.

One of these sub-committees is studying the vibrations of transmission line conductors—a question which is agitating the minds of power transmission engineers and executives all over the world. This phenomenon became apparent only within recent years, following the adoption of longer spans (and consequently higher mechanical tensions) in an effort to reduce the cost of transmission lines. Under certain conditions the conductors vibrate rapidly and eventually fail by fatigue. Millions of dollars have been spent in research and numerous devices have been developed to protect the conductors against the vibrations, but no finality has yet been reached. When the sub-committee began its work the need of improved means of observing and recording the vibrations was quickly apparent and its first efforts were devoted to developing equipment for this purpose. A method has been successfully applied whereby information about the vibrations may be obtained on an oscillograph record. This permits a determination of the bending and stress in the conductor caused by vibration and of the relative merits of vibration absorbers. The solution of the problem of vibration is of immense economic importance to the power companies since it will remove one of the present limitations to conductor spans and will tend to reduce the cost of transmission lines. It is felt that a contribution of value has been made by the work of the committee.

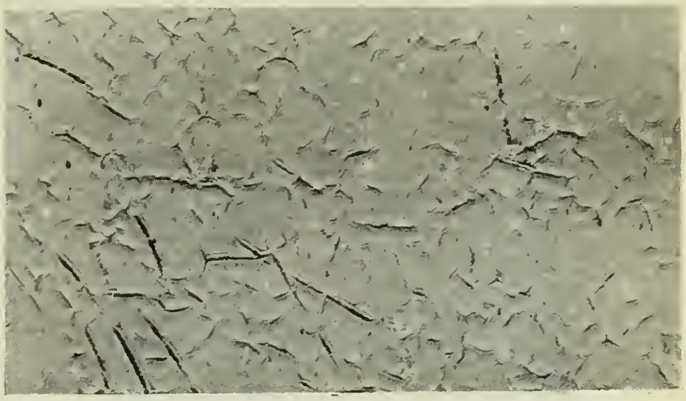

Fig. 6—Sample of Paint taken from Weather Meter.

Another sub-committee is studying wooden transmission structures, having in view the development of means of lengthening the life of such structures. This work involves comparative tests on preservative materials, systematic and detailed inspection of poles in service, the installation and observation of test beds in soils of different types, and the recommendation of measures for the prevention of decay.

Many suggestions have been made to the Commission for the utilization of off-peak power. Some of these, particularly several involving the production of gases by electrolysis, have been studied by the committee.

The application of electric heat to soil has been shown to promote plant growth. This offers an attractive load to power companies, particularly in greenhouses. A sub-committee is studying this subject and has obtained very encouraging results in co-operation with growers and manufacturers of equipment. A good deal of scientific work must still be done to determine the most efficient method of applying the heat, and the co-operation of botanists is being sought.

Other sub-committees are studying insulating and lubricating oils, paint, the efficiency of electrical cooking appliances, methods of remote control of loads, and electrical insulation.

The Commission's water heater campaign introduced a problem in the development of a cheap thermostat capable of breaking a current of 25 amperes. The laboratory in co-operation with a manufacturer succeeded in developing such a device. Studies of thermal insulation, heater efficiencies, etc., in connection with the same question resulted in the obtaining of a high grade electric water heating system at a much lower cost per unit than was possible at the commencement of the campaign.

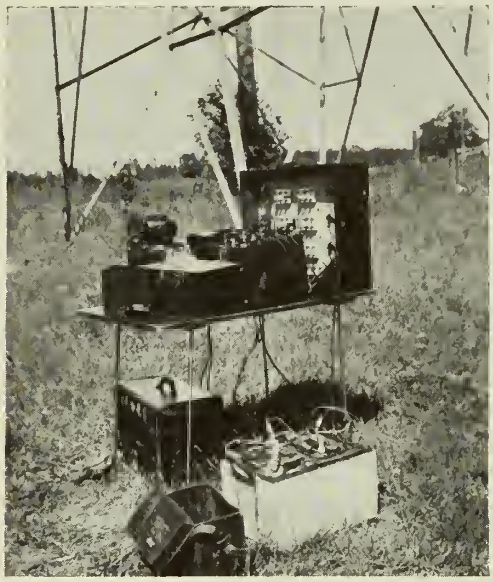

Fig. 7—Equipment for Studying Vibrations of Transmission Line Conductors.

The development of equipment, while not primarily the concern of a power company, is sometimes necessary for various reasons—technical and monetary. Equipment for a specific purpose may not be available at a price which would warrant its purchase, and on the other hand someone on the staff may suggest a solution which appears feasible and economical. Many such cases have arisen in the Commission's history for which solutions have been found. One of the first was a method of testing defective insulators on live lines. Much work has been devoted also to means of indicating and recording abnormal voltages on high tension lines. One of the most recent developments was carried on in co-operation with a manufacturer and resulted in a potential device adapted to 110-kv. and 220-kv. lines. The cost of this, as produced by the manufacturer, is less than one-tenth of the cost of available standard equipment for similar service. While the latter equipment would furnish more information than the device developed—in fact more information than needed—the consideration of price and space occupied rendered its use uneconomical. This is an example of research suggested by a requirement which existing equipment failed to meet economically.

The research work brings the laboratory into contact not only with other departments but with outside organizations. Problems involving the Commission with communication companies arise when power and communication lines run parallel to one another with relatively small separation. The solution of these problems of inductive co-ordination often involves special testing and theoretical investigations. Other troublesome questions often arise when radio owners in the neighbourhood of high voltage lines complain of poor reception. The laboratories have co-operated with the communication companies and the Federal Radio Branch of the Department of Marine in investigating many of these problems.

The department also assisted the Banting Research Institute in an extensive research on the effects of electric shock; its particular part in this investigation being the development of precise methods of controlling the application of electricity.

The investigation of operating problems can scarcely be classed as research, although in many cases it involves the application of mathematical analysis and advanced experimental methods. The failure of equipment often presents problems which demand the application of high technical skill. The cause of failure may be an abnormal stress upon the equipment or a weakening of the equipment material owing to defective design or construction, so that it is unable to withstand the normal stress of operation. These studies often involve the application of the keenest analysis.

The development of research in power companies within recent years is the result of the recognition of the necessity of supplementing investigational work in the development of new equipment by field studies. The greater part of engineering research has in the past been carried on by manufacturers and perhaps in amount it still exceeds that conducted by power companies. In a certain sense the power systems become experimental laboratories for the manufacturers, since progress in the design of new equipment depends upon the observation of its behaviour under operating conditions and detailed knowledge of these conditions. A commercial organization, however, must of necessity have a point of view somewhat different from that of a power company. It is required to show a profit and it cannot carry on research in any line indefinitely without producing something of marketable value. The power company then is frequently under the necessity of choosing between competitive products developed in different research laboratories and submitted as solutions of its operating problems. For these reasons power companies have been forced to carry on research on their own account.

It follows from the considerations which have been presented that testing and research are inseparably connected. The Testing Laboratory even in its routine work encounters problems to which the methods of research must be applied for solution. New test methods must be devised and existing methods must be improved. Testing technique must keep pace with advances in engineering practice, and with the production of new materials and equipment. Thus the problems of routine testing give rise to research and on the other hand, research can only be carried on by making use of routine test methods. In fact, the two are interdependent.

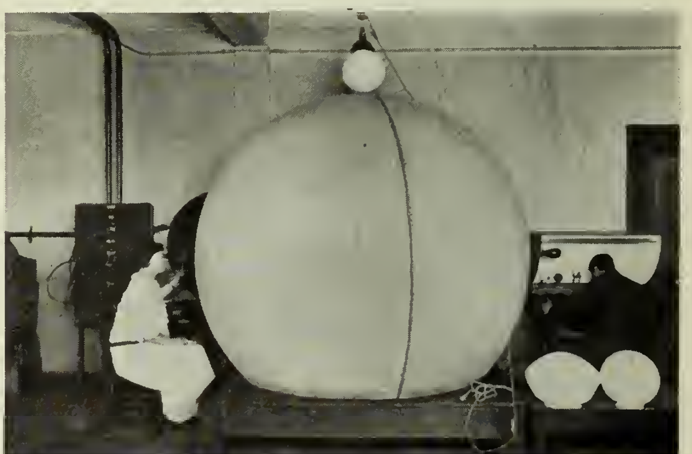

Fig. 8—Integrating Sphere Photometer.

VALUE OF THIS WORK TO A POWER COMPANY

The value of a department, such as has been described, is manifold:

(*a*) It saves money for the organization both in capital cost and in maintenance and operation. In the purchasing of equipment and material a proper balance between price and quality can be obtained in no better way than by following the methods which have been outlined. Certainty, of course, is not attainable, but many uncertainties are resolved, and as test methods are developed and applied more widely the advantage of purchasing in this way will become more apparent. Not only do these methods save money in capital but they also reduce maintenance costs, for it follows that the better the quality of equipment the longer will be its life and the less the cost of its maintenance.

(*b*) Improvement in service naturally follows from the adoption of methods which will improve material and equipment.

(*c*) The laboratory exercises a preventive and protective function which is perhaps one of its intangible advantages and may be called "Preventive Engineering." Although it cannot promise perfect health and indefinite life to equipment any more than preventive medicine can make a similar promise to human beings, yet it is undeniable that important benefits follow the sound application of these methods in the former as well as in the latter case. While definite savings cannot always be estimated or pointed out, there are cases in which this can be done. It is known, for example, to mention a few cases, that several hundred thousand dollars were saved in concrete materials on the Queenston and Chats Falls jobs as a result of laboratory control; that the assistance rendered the Operating Department in connection with painting has produced definite reduction in maintenance costs; that the co-operation of the laboratory and municipal departments in the water heater campaign effected savings in the supply of water-heating equipment; that the recommendations of the Chemical Laboratory for the painting of steel penstocks on one of the Niagara plants reduced the maintenance of these to practically nothing over a period of nine years; that the Chemical Laboratory developed a dressing for tree wounds, which effected a saving of several dollars a gallon over that previously obtainable.

(*d*) The value to an organization of an accumulated fund of information directly applicable to its problems and the skill of a staff trained in its service and familiar with its operation is more than an intangible asset. It becomes in case of emergency a real factor in providing a remedy unobtainable from any outside agency.

(*e*) The centralization of testing and research facilities in a single department has many advantages; it avoids duplication of staff and equipment and provides a specialized service not otherwise obtainable at the same cost.

The cost of the service rendered by such a laboratory is negligible in comparison with the benefits, tangible and intangible, which it returns. It is necessary, however, that the equipment and staff to be of maximum value must be adequate to supply a varied service. This involves a fairly large capital expenditure and can be undertaken only by a moderately large company. It is not necessary thereby to duplicate research facilities existing in universities or in national research institutions. The necessity for familiarity with the organization and its operating problems places a limit upon the direct assistance which can be expected from such institutions. Every effort is made, however, to co-operate with research institutions, so that purely scientific problems may be referred to the proper authorities and the results made available. The power company may suggest problems in pure science the solution of which may have a wide application and the maximum benefit is thus obtained from the union of research in pure science and in engineering.

Report on Tenders and Contracts for Public Works

from the

Council of The Engineering Institute of Canada

to the

Canadian Chamber of Commerce

Montreal, January 1935

Gentlemen:—

The following report has been prepared in response to a request from you for recommendations and comments as to the practice which is desirable as regards the calling of tenders for public works, the manner in which these tenders are dealt with, the interpretation given to contracts in operation, and the inspection and final acceptance of public works carried out by contract.

The report is based upon the findings of a committee appointed by the Council of The Institute, composed of the following five members, two of whom are public officials, two officers of contracting organizations, and one an engineer in consulting practice:—

Chairman—R. E. Chadwick, M.E.I.C.,
President, The Foundation Co. of Canada, Limited, Montreal.

Members —W. E. Bonn, A.M.E.I.C.,
Engineer, Canadian Dredging Company, Limited, Toronto.

Lieut.-Colonel C. S. L. Hertzberg, M.E.I.C.,
Harkness and Hertzberg, consulting engineers, Toronto.

Dr. O. O. Lefebvre, M.E.I.C.,
Chief Engineer, Quebec Streams Commission, Montreal.

D. W. McLachlan, M.E.I.C.,
Engineer, Department of Railways and Canals, Ottawa.

This committee (referred to hereinafter as our committee) has dealt with the subject under two general headings, namely:—

I. The practice as regards the calling of tenders for public works and the manner in which these tenders are dealt with.

II. The interpretation given to contracts in operation and the inspection and final acceptance of public works carried out by contract.

I. Practice as Regards the Calling of Tenders for Public Works and the Manner in which these Tenders are Dealt With.

(1) *Advertising for Tenders.*

In general the present practice in Canada is to call for tenders for public works by advertisement in the daily newspapers of the locality in which the work is to be executed, and in the daily newspapers of the principal cities and in the technical press.

Our committee is of the opinion that in advertising for tenders a great deal of unnecessary expense is incurred through the widespread and repeated publication of advertisements in newspapers that do not in the ordinary course of events reach prospective tenderers. Our committee is of the opinion that where the call for tenders is advertised, sufficient publicity would be given if the advertisement appeared only once in the technical press and in the daily press of the locality and of the capital city of the province in which the work is to be done, including, in the case of the province of Quebec, one French and one English newspaper.

(2) *Selection of qualified bidders.*

Under the existing general practice of calling for tenders for public works in Canada, no serious attempt is made to eliminate tenders from irresponsible contractors, contractors obviously lacking the equipment, organization and skill necessary to carry out the work, and so-called "brokers" who contemplate subletting the work to others in the event of their tenders being accepted by reason of being the lowest submitted. Our committee is of the opinion that tenderers should be restricted to bona fide firms and corporations regularly established in the construction business and controlled within the British Empire for some period commensurate with the importance of the work.

In the case of important engineering works the practice of calling for tenders by public advertisement without requiring evidence of qualification on the part of prospective bidders appears to be a practice established principally in the United States and Canada. The British practice appears to be to call for tenders for important works from a selected list of regularly established British contractors only, who have previously satisfied the authorities that they have the equipment, personnel, experience and financial backing necessary to carry out successfully the work contemplated.

Our committee recommends that a similar system be adopted in Canada in the case of important public works, more particularly in the case of engineering works where a substantial proportion of the cost is represented by work that is underground or under water. It is believed that such a system would result in a higher grade of workmanship at an ultimate cost to the public substantially less than that realized under the present system. Our committee points out that in requiring prospective bidders to submit proof of competency our public authorities would be following well established business principles, and what would appear to be established public practice elsewhere than on the American continent. Our committee observes that the practice of calling for tenders from a list of qualified contractors as suggested, has already been followed with marked success, in the case of important contracts, by some of our public bodies.

It must be recognized that the general practice of restricting tenderers to a selected list of contractors could probably succeed in Canada only if actively supported by public opinion and by the representative engineering or contracting organizations such as The Engineering Institute and the Canadian Construction Association. Otherwise, and without this support, the selection of bidders would doubtless tend to be based on political considerations rather than on merit and an honest desire to secure skilfully executed work at the best possible price.

In order to avoid any possibility of personal influence, the selection for the lists should be made and the lists drawn up by public departments or by such organizations as those just named. Provision should also be made for the addition to these lists from time to time of firms whose standing and resources have developed so as to justify their inclusion.

One member of our committee did not endorse the above in its entirety and his views are submitted in the footnote below.*

(3) *British Empire Organizations.*

Our committee believes that tenders for public works in Canada should be accepted only from bona fide contracting organizations controlled within the British Empire, but recognizing the difficulty of establishing the domicile of the real owners of an incorporated company, suggests as a further condition of qualification that the tenderer be regularly established within the Empire for some length of time commensurate with the importance of the work.

In this connection attention is called to the recent regrettable decision of the Colonial Office, London, restricting tenders for certain harbour work in Trinidad to United Kingdom contractors and declining to permit Canadian contractors to submit proposals for the work.

While recommending that tenders be received only from British Empire organizations, our committee wishes to go on record as being opposed to the practice of certain municipalities in restricting tenderers for important work to contractors of that particular city only. A restriction of this kind is comparable to a customs duty protecting a manufacturer and it does not appear to be in the public interest to set up trade barriers within the limits of the Dominion itself.

(4) *Adequate preliminary investigation needed.*

Our committee remarks that, in the case of construction, a substantial portion of the cost of which is represented by work that is underground or under water, the plans and specifications upon which tenders are asked often fail to give sufficient information in the way of soundings and borings to enable a contractor to submit an accurate tender. Our committee considers it a duty of the authority calling for tenders to have made a proper engineering investigation of the site of the work, including sufficient borings to determine as accurately as practicable the nature of the soil and the subsurface conditions, and that it should be recognized that the tender is based on the information furnished. Suitable provision should be made in all lump sum contracts for adjustment in price either as an increase or decrease, as the case may be, in the event of the level of rock varying from that indicated.

Our committee believes that lack of proper preliminary engineering investigation, borings, etc., increases in the aggregate the cost of public works in Canada by a very large amount, and often leads to unnecessary and costly "extras."

Our committee calls attention to the custom of inserting in public works' contracts various clauses under which the contractor is required to declare that the contract is

* A dissent from the recommendation of the majority of the committee that tenders for public work be restricted to a previously prepared list of approved contractors as outlined in Section I (2) was recorded by Mr. McLachlan. He believes dark horse bidding tends to keep contract prices from becoming unduly high.

He believes barriers should not be thrown in the way of new contractors if they have sufficient financial resources and can show a reasonable procedure for securing the plant and personnel required for the proper execution of the work.

He also believes the statement of the majority as to British practice conforming with their proposal is too sweeping.

based solely on information which he himself has obtained, and that he has not relied upon the borings, tests, surveys, plans, profiles and specifications furnished by the engineer. It is an economical and, in many cases, a physical impossibility for each contractor tendering to duplicate the investigations, borings and surveys of the designing engineer. To do this would add substantially to the cost of construction generally. It does not appear to be in the public interest to ask a contractor to make a declaration in his tender that is not in accordance with the facts, and it is obvious that a contract based on a false declaration leads to claims, extras and litigation, and ultimately increases the cost of our public works. It is obviously necessary that a contractor, before submitting a tender, be required to visit the site of the work and to ascertain for himself the conditions under which the contract must be carried out, and our committee believes that he should be required to make a declaration to this effect.

(5) *Unit price contracts.*

Construction contracts for public works are usually based on a lump sum price for a specific piece of work, with or without provision for increases and deductions, or on a schedule of unit prices for each particular class of work. Either of these types of contract is satisfactory, and the general practice is to use the lump sum form of contract for building work and the unit price form for engineering work in which the exact quantities cannot be accurately predetermined.

Disputes occasionally arise in connection with the award of unit price contracts where through a clerical error the extensions or totals do not check with the quantities and unit prices. In this matter our committee is of the opinion that where an error is made the unit price should be held to be binding and the error in extension and in the total should be corrected, and that to avoid any possibility of dispute the instructions to bidders should state clearly that this rule will be followed.

In the case of unit price contracts involving excavation to any considerable depth below water level or ground level, our committee is of the opinion that the basic price for excavation should be for work to the expected depth, and that there should be a scale of prices for extras and deductions that vary according to the depth to which they are to apply. Otherwise no tender can be said to be "balanced" so far as the excavation items are concerned. The cost clearly increases with the depth, and without a differential scale a variation in depth results in either a loss or an excessive profit to one or other of the parties to the contract, whereas the intention of the unit price contract is that each and every item of work shall be rated at a price that will permit of changes in quantities being made without undue advantage to either the contractor or the public.

Our committee is of the opinion that it should be stipulated in all unit price contracts that tenders must be "balanced," meaning that each unit price must be reasonable in comparison with all others in the same tender. Under this restriction a contractor is barred from quoting a low price on items of work that he thinks may be increased, with the intention of showing the lowest possible figure for the total amount on which the contract is awarded. The principle of unbalanced bidding can be and has been used, through fraud and collusion on the part of the engineer and the contractor, to award contracts to tenderers that are not in fact the lowest bidders. All specifications or instructions to bidders on unit price contracts should contain a clause to the effect that bids which in the opinion of the engineer are unbalanced will be rejected and that this rule should be enforced, even though it results in the acceptance of a higher tender.

It is recommended that in the case of all unit price contracts, the tender form clearly state the engineer's estimate of the quantity of each class of work, and that the several tenders be compared on the basis of these quantities. While this is the practice generally followed, it is not universal. Our committee is of the opinion that the omission of the bill of quantities from the tender form encourages "unbalanced" bidding and collusion.

Our committee goes on record as condemning the practice of including in tender forms prices on alternative types of construction or equipment to an extent that may give rise to doubt as to which of two tenders may in fact be the lower, and which could result in a summation unduly favouring some one contractor. Where alternatives are considered necessary complete plans should in all cases be prepared by the engineer.

(6) *Guarantee that contract will be signed.*

It is necessary that there be some form of guarantee that a bidder, if his bid be accepted, will enter into a formal contract for the execution of the work. The practice as regards the form of this guarantee varies, some public authorities requiring a bond commonly known as a "bid bond," others a certified cheque on a Canadian chartered bank, and others the deposit of securities in the form of bonds of the authority calling for the tenders. In some cases some combination of two or of three of the above types of security is required.

Our committee recommends as the most satisfactory form of security the certified cheque, and is of the opinion that the so-called "bid bond" is not desirable on the ground that it could probably be enforced only after protracted litigation.

Attention is called to the practice of certain of our public authorities of cashing or depositing to their own account bid cheques submitted by contractors as guarantees that they will enter into a contract. This practice should be discontinued. In the opinion of our committee no public authority should appropriate to its own use moneys so deposited.

(7) *Delays in awarding contracts.*

Our committee also condemns the practice on the part of certain public authorities of holding bid cheques for more than a few days pending the award of a contract. This practice should be discouraged.

The practice of holding bid cheques, either cashed or uncashed, for an unnecessary length of time, places on the construction industry as a whole a substantial financial burden which must ultimately be passed on to the public in the form of increased costs. The amount of money deposited in the form of bid cheques and contractors' guarantees during any period will aggregate probably fifty per cent of the total value of work undertaken, and the public doubtless does not realize that it is under present practice paying unnecessary interest charges on this vast sum of idle capital. The practice of cashing bid cheques is particularly objectionable as this in general about triples the carrying charges.

It would appear obvious that if a contract is to be let to the lowest responsible bidder, the award can and should, as a general rule, be made within three days of the time of receiving tenders, and all cheques other than those of the lowest bidders can then be returned. In this connection our committee recommends the practice of the Department of Public Works of Canada, under which the cheques of all contractors whose tenders are obviously not acceptable are returned on the day they are received, the general practice being to hold until the contract is signed the cheques of the three lowest bidders only. If for any reason tenders have to be held over for analysis, the time and date on which the award is to be made should be announced at the time.

(8) *Guarantee for performance of contract.*

It is customary and advisable that there be some tangible form of guarantee that a contractor will complete the work after having signed the contract. The practice in this respect is to provide for monthly payments on account, less a stipulated percentage to be retained until the expiry of the date within which liens can be registered after the completion of the work. In addition it is customary to require the contractor to furnish a bond guaranteeing the completion of the work, or in lieu thereof, to deposit securities in the form of bonds of the authority giving the contract. Our committee is of the opinion that the bond is not a satisfactory form of security owing to the difficulty of enforcement. The requirement for a bond adds at least one per cent to the cost of the work with no commensurate advantages, which additional cost must eventually be passed on to the public. It is considered that a deposit of cash or of securities constitutes the best form of guarantee and offers in itself assurance that the contractor is to some extent financially responsible.

Our committee is of the opinion that the requirement of a performance bond rather than a deposit of cash or its equivalent is wrong in principle, as under the bonding system those contractors who operate their businesses efficiently inevitably, through their bond premiums, make good the losses of those who fail. A tax on the efficient operator for the benefit of the inefficient operator is not in the public interest.

(9) *Fair-wage clauses.*

It is customary for all public works contracts to include a so-called "fair-wage" clause stipulating the minimum rates of wages that are to be paid. Certain public bodies stipulate in general terms that the contractor must pay the union or prevailing rate of wages. Other authorities attach a schedule giving the minimum rates of wages for each trade. Our committee concurs in the advisability of a fair wage clause and recommends in this connection the practice of the Dominion Government in stipulating definitely the rates for each trade, rather than a general requirement to the effect that the contractor is to pay a union or prevailing rate. It is often difficult, on account of the jurisdictional differences between the unions themselves, to determine precisely what the so-called "union" rate is, and it is obviously difficult to say what the prevailing rate may be.

Having stipulated the number of hours constituting a working day or week and a so-called "fair wage" which is the minimum the contractor under his contract is permitted to pay, a public authority should, in the event of its ordering any change in the hours of work or an increase in rates, fairly compensate the contractor for any extra cost imposed upon him on this account. Similarly, if a change in hours of work or in rates of pay is ordered which results in a decrease in cost, the contractor should be required to rebate the amount of the saving effected.

While concurring in the advisability of a fair wage clause, our committee is of the opinion that in many cases the schedule rates are excessive and exceed those actually prevailing in the district in which the work is to be done, and go on record as condemning this practice, feeling that it adds unnecessarily to the cost of public works and tends to establish an artificial rate that has the effect of discouraging private construction.

(10) *Delivery and Opening of Tenders.*

Our committee calls attention to the fact that while under our Canadian practice public works are ostensibly let by public tender, comparatively few of our public bodies actually let their contracts in public, that is, receive and open their tenders in public and disclose the prices tendered. Tenders are in most cases received by mail or by hand up to a given time, to be opened at some later date. This practice frequently results in suspicion that tenders are tampered with between the time they are received and the time they are intended to be opened, and it has been from time to time suspected that favoured contractors have been permitted to submit revised bids after all tenders are in and the original prices known.

In this connection our committee recommends the practice of the Department of Public Works of Canada, under which tenders may be sent by mail or be delivered by hand, at the option of the bidder, up to a given time, and are then immediately opened in the presence of two responsible officials of the Department and in the presence of those bidders who wish to be present, and the figures read out to the assembled meeting. Under this system, which has been firmly established for many years, there can be no suspicion of fraud or of collusion in regard to the tenders. It is suggested that the practice of the Department might be further improved by the requirement that all tenders be delivered by registered, not ordinary mail, or at the option of the tenderer, be delivered by hand at the actual meeting at which they are to be opened.

Our committee strongly condemns the following practice which appears to be quite prevalent in the handling of so-called "public" tenders, viz.:—The practice of receiving tenders up to a given time and holding them, ostensibly unopened, to be dealt with at some subsequent meeting. Provision should be made in all cases for tenders to be handed to the official who is to open them, and for them to be opened then without having passed through the hands of any third party.

(11) *Acceptance of Lowest Tender.*

Our committee is of the opinion that it is not in the public interest that a contract be awarded to the lowest bidder where, by comparing the low tender with the engineer's estimate and with other bona fide tenders it is obvious that the low tender is the result of an error in judgment, lack of experience, or failure to appreciate the requirements of the work, and that the work cannot be executed in accordance with the specifications for the price tendered. In cases of this kind our committee is of the opinion that the low bid should be rejected and the contract given to the next lowest properly qualified bidder. Our committee is strongly opposed to the policy, which has at times been followed, of rejecting all bids and calling new tenders, on the ground that this can serve no useful purpose, delays the work and is obviously unfair to all bona fide bidders and particularly to that contractor who is entitled to the work and whose price is disclosed to his competitors.

II. The Interpretation Given to Contracts in Operation and the Inspection and Final Acceptance of Public Works Carried out by Contract.

(12) *Brevity of documents.*

It is believed that many of the specifications and contract forms presently used could be advantageously shortened and put into simpler language more comprehensible to those to be governed thereby. It is also felt that many of the clauses are unfair to the contractor.

(13) *Unknown sub-surface conditions.*

Our committee is of the opinion that where sub-surface conditions are not known or cannot be determined with reasonable accuracy prior to the calling of tenders, the contract should be so drawn as to provide for the handling on a cost-plus basis of that portion of the work that is affected, as, for example, cofferdamming, unwatering and perhaps also, excavation. A policy of handling such work on a cost-plus basis would, it is felt, give the supervising engineer more direct control over an operation essential to the success of the work as a whole, but the details of which cannot in many cases be accurately specified in the first instance.

(14) *Restrictions in use of machinery.*

Our committee is of the opinion that when restrictions in the use of machinery in place of hand labour are deemed advisable in the public interest, they should be fully and clearly set out in the original specifications and no deviation therefrom should be subsequently used as an excuse for changing the contract prices.

(15) *Enforcement of time limits.*

Our committee draws attention to the desirability of a strict enforcement of the time limits of contracts. In its opinion a reasonable time limit for commencing work and a reasonable rate of progress should be specified and enforced.

(16) *Supervision by qualified engineers.*

Our committee suggests that a decided improvement might be effected in the execution of our public works if they were always, while work is in progress, under the direct supervision of fully qualified engineers.

(17) *Strict adherence to specifications.*

It is the general consensus of opinion that in the administration of public works' contracts there is a tendency on the part of some engineers and inspectors to assist the irresponsible contractor who has, perhaps, in the first instance bid the work at a price that is obviously too low, this assistance being given by granting extras and a more favourable classification than is justified. Our committee is of the opinion that contractors should be required to execute their work strictly in accordance with their contracts, and that no extras should be allowed unless for work that is in addition to that contracted for. When a policy of definitely requiring strict adherence to the specifications is established, this fact soon becomes apparent to all interested contractors and bids are made accordingly, and a better quality of workmanship and a lower ultimate cost to the public results.

(18) *Appeal from engineers' decisions.*

Public works' contracts usually appoint the engineer or architect, as the case may be, the sole and final arbiter in regard to the interpretation of the plans and specifications, and in regard to the quality and quantity of the work done. Our committee is of the opinion that in the final adjustment of a contract there should be provision for appeal from the decision of the engineer or architect to a board of arbitration such as, for example, that provided by the Ontario Arbitration Act, except in cases where appeal is otherwise provided for, as in the case of appeal to the Exchequer Court in the case of Dominion Government contracts.

(19) *Service grounds, disposal areas, etc.*

Our committee is of the opinion that where service grounds, borrow pits, or disposal areas are definitely required for the execution of any given work, they should be arranged for and provided by the public authority in advance of calling for tenders. The term "service ground" refers to any property outside the actual area occupied by the finished work but which is necessary for the purpose of carrying out the work; the term "borrow pit" refers to any area of ground from which it is necessary to take material to be used as fill in the finished work; and the term "disposal area" refers to any property which is necessary for the disposal of surplus excavated material.

It is felt that where service grounds, borrow pits and disposal areas are essential, they can be secured in advance by the public authority at a much lower price than they can subsequently be secured by whatever contractor may be entrusted with the work. Generally speaking, the knowledge that an operation is actually about to commence enhances, often to an exaggerated extent, the value of properties required in its execution, and the cost of the work is often materially increased on this account, and in this connection it must be pointed out that the contractor lacks the power of expropriation usually available to the public authority.

It should be pointed out that this clause refers principally to the larger engineering projects and, as a general rule, is neither applicable nor necessary in the case of building construction.

(20) *Employment of consulting engineers and architects.*

Our committee takes the liberty of expressing its views on a point that appears pertinent to, although perhaps not strictly included in, the several points upon which it was asked to report.

Our committee commends the employment of consulting engineers in an advisory capacity on public works in special cases and for the design of works for which there is no permanent staff available. It also suggests that architects might with advantage be retained in a consulting capacity in connection with our engineering works that include buildings, and in connection with our more important bridges. In the opinion of our committee Canada has reached a stage in her development where æsthetics should assume a more important role in the design of our engineering structures.

The whole respectfully submitted on behalf of the Council of

THE ENGINEERING INSTITUTE OF CANADA

F. P. SHEARWOOD, M.E.I.C.,
President.

R. J. DURLEY, M.E.I.C.,
Secretary.

Montreal, Quebec,
January 18th, 1935.

The English Bay Interceptor, Vancouver

G. M. Gilbert, A.M.E.I.C.[1]

DISCUSSION

A. D. Creer, M.E.I.C.[2]

The writer was resident engineer under Mr. R. S. Lea, M.E.I.C., on the preliminary investigation in 1911 and 1912 and was chief engineer to the Joint Sewerage Board from its formation to 1921. It was largely through the efforts of the Hon. H. H. Stevens when he was an alderman on the city council that the Joint Board was formed and at that time it included in its area four municipalities.

Some years were spent on investigations and a preliminary report was presented to the Burrard Peninsula Joint Sewerage Committee, which resulted in the formation by the provincial government of the Vancouver and Districts Joint Sewerage and Drainage Board.

This preliminary report laid down the general lines of a complete scheme for the whole area, with an estimate of the population and ultimate cost of the undertaking. The population was put at 1,450,000 in 1950 and the cost at $10,000,000, the only criticism being that the population was under estimated. (In 1910 the population was 150,000 and in 1934 it was 300,000.) These figures were later cut to 800,000 and the design revised. The question of the separate or combined system for the English bay area was considered thoroughly and while the preliminary report advised the adoption of the former, the Board decided on the combined system. About that time the New York Sewerage Commission had laid down a standard of purity for bathing beaches as "approximating that of drinking water" and as the shore of English bay from False creek to Point Grey is one continuous bathing beach, it was felt that as the additional cost of the separate system was not prohibitive, it would be wise to adopt this system and give the maximum protection to the beaches.

Time will prove that this view was correct. It is likely, however, that as the population increases and the overflows come into more continuous operation, either the bathing beaches will have to be abandoned as such or further provision made for carrying the overflows or trunk outlets considerably further out from the shore.

It is also questionable whether the point of outlet at Imperial street as selected, will continue to be satisfactory. The currents are slow and have little dispersion value. There will be a tendency, when the volume of flow increases, for the sewage to move en masse and become a major nuisance. It would have been wiser to have deferred the construction of the interceptor and lengthened the trunk outfalls watching the results as time went on and the population and flow increased.

It is quite within the bounds of possibility that ultimately an interceptor may have to be carried in the opposite direction, syphoning under False creek to the neighbourhood of Prospect Point where high velocity currents are available for proper dispersion.

Another criticism is that the size of the interceptor at its upper end should have been larger; the cost of excavation for a 4-foot 6-inch tunnel sewer is practically the same as for a 5-foot, and the additional capacity would have been useful in preventing to a greater extent the pollution of False creek.

As regards grit chambers the writer's experience has led to the conclusion that the cheapest and most satisfactory way to get rid of grit is to allow it to go into the sewers and then flush it out. Also, with reference to the cost of the work as compared with day labour work, a considerable saving would have been effected if the work had been done by contract.

J. M. Begg, M.E.I.C.[3]

As this extended paper may from time to time be consulted as an authoritative record the writer would like to incorporate in the discussion some comments suggested by a reading of an advance proof.

The run-off factor (25 per cent) for the Balaclava area may strike the reader as needing some explanation when applied to an area likely to be well built up in the future. It is not strictly comparable with the run-off factor used in storm sewer design. It was little more than an allowance for light summer rainfall and for the first rush of storm water after a dry spell. Its selection was influenced by considerations not all readily expressible in arithmetic. Mr. R. S. Lea reached a similar final result but it was by a different method. It is to be noted that as design was based in an estimate of the flow of sewage for the maximum hour of the minimum day there is at all other times room in the sewer for more rainfall than the amount obtained by the calculation.

In the original 1912 scheme Mr. Lea had recommended the separate system for the area tributary to the interceptor, but this had been abandoned at an early stage in the history of the Board, a step which imposed on the new design a corresponding change in method. Conditions as they are likely to be some thirty or forty years hence were fully realized and provided for.

Some apparent inconsistency in the author's hydraulics may be cleared up by explaining that the formula used in determining the dimensions of the sewer required for a given rate of flow was that of Hazen and Williams. Chezy was used only for preliminary sketches of some subsidiary structures. The statement that the hydraulic radius of an 8-foot horse shoe section is 2, in so far as it suggests that the section was treated as a circle, implies a looser standard of approximation than was in fact maintained whenever possible in all final hydraulic computation.

The estimated maximum rate of flow relative to the average was increased towards the upper end of the interceptor to allow for a greater fluctuation in the discharge from smaller tributary area.

The thorough investigation on which Mr. Lea's 1912 scheme for the whole peninsula was founded included a study of probable future population. It was mainly on this with a few emendations suggested by the passage of time that design was based. The Town Planning Commission's estimate became available before construction began, and the plans, already well advanced, were checked by the new figures, but the results varied little from those already adopted, a slight increase being covered by a small margin of capacity already provided.

The writer hardly hoped to make the butt joint on the outfall watertight in itself. Experience of subaqueous work, and of the human element involved in it, led him to endeavour to design a joint which would, if pulled well home by mechanical means, ensure the beginning of tightness. He was then thinking of lead wool for filling the recesses and had a long eye to the possibility that in such

(1) Paper presented before the Western Professional Meeting of The Engineering Institute of Canada, held at Vancouver, B.C., on July 11th to 14th, 1934, and published in the September, 1934, issue of The Engineering Journal.

(2) 1984–45th Street, Vancouver, B.C.

(3) Cumnock, Ayrshire, Scotland. Chief Engineer, Vancouver and Districts Joint Sewerage and Drainage Board 1924-1933.

deep and often turbid water the caulking at some joints might be imperfect. The butt joint plus a filling even of the surrounding silt would give a joint of a kind. The discovery of a compound which enabled the filling to be placed with ease was fortunate. The joint is not so much a "tongue and groove" as a development of the bell and spigot type which naturally emerges when one gives the recess a wedge shape in order to hold the filling. The conical shape of the abutting surfaces should be noted. This keeps contiguous pipe concentric when pulled into position. It is necessary that the cradle of steel rails be truly and carefully laid on as carefully prepared caps and piling, a condition which in this particular case only the author's tenacity and meticulous instrument work in all weathers made possible of fulfilment. The writer wishes also to acknowledge his debt on a vital point to published papers on the work of other engineers on the Pacific coast, and to an unknown American contractor with whom he once discussed the subject.

The depression or channel in the silt of the ocean bed at the 2,000-foot point from shore, though a source of anxiety, presented a problem of unusual interest. There was daily a general ocean current across the line of the outfall of about half a mile to five miles per hour as measured at the surface. The presence of a distinct and individual current in the channel 70 feet or so below, more rapid than that in the surrounding sea, was more a matter of inference from the existence of the channel itself than from the inconclusive evidence obtained by direct observation. There was nothing improbable in the formation of a current by the edge of Spanish Banks, but it seemed curious, if not improbable, that after leaving the Banks it should still maintain itself in the open water a mile further east as something in the nature of a submarine stream, a thread comparatively, in the great body of the surrounding water, permeated, as it was, by the complex and involved currents revealed by the floats. This doubt was not lessened by reports of previous dredging operations. It seemed reasonable to suppose that in any case, if it did exist, an intermittent current of any likely velocity, while the danger of its turning right or left was recognized, could be readily enough diverted upwards into the water above by a long sloping fill protected, if necessary, and especially from scour on the lea side by gravel. Even when teredo attacked the trestle there seemed to the writer to be conflicting elements in the evidence as to the cause of exposure of the piling, but the obvious explanation was accepted and in the repair shop it was decided to risk the danger to which creosoted piling would be subject from ships' anchors, and leave, to support the pipe across the channel, an open trestle permitting free passage between the bents. There was the additional consideration that it would the more securely keep the current crossing at a known point. In 1933, two years later, and after two flood seasons on the Fraser, the piling and channel were examined by a diver. There appeared to be no erosion of the channel under the pipe, but the piling itself, due possibly to a dragging anchor, showed signs of damage. The greater part of the rest of the outfall had by now been protected by gravel, this being done gradually as the fill of the silt subsided and packed round the pile foundations or was subject to erosion. The diversion of a possible current was therefore less to be feared than a break in the creosoted surface of the piling permitting the entrance of teredo. The crossing at the channel was accordingly finally filled in with gravel.

The hydraulics of the system were arranged to permit the installation at any time necessary, of a screening plant at the foot of Imperial street, but the excellent results of operation at the outlet selected by Mr. Lea, make it seem unlikely that screening will be required.

One or two calculations such as that based on a figure given in Fowler's work on foundations did not perhaps quite deserve the publicity conferred on them by a formal paper. They were written down in passing to throw a side light on the point under consideration and were not the basis of design. The same applies in some degree to the calculation of the probable concurrence of rainfall and high tide at the foreshore. The writer is not himself enough of a mathematician to be sure whether or not a strict member of that fraternity would demur to an assumption that the alternatives in this instance are equally likely possibilities in the sense required for the computation, or might not go further even and insist on a distinction here between probability and frequency. Some limitation of data in any case there was, and the result of the subsequent calculation, when transformed into probable frequency over a period of time, was accepted only as a rough guide to judgment.

In calculating the heights of the curving weirs approximate values for certain factors such as the coefficient of roughness in the existing sewer were assumed or estimated by inspection, and the weirs so built that they could be readily raised or lowered, the final adjustment of elevation to be determined by the results of prolonged operation.

The disintegration of lead wool in some old joints may have been due to incomplete caulking and consolidation. Part was still of more or less fibrous texture.

The two-inch paving finish contained clean sharp sand as well as pump-sand, being composed of one part cement, one part washed sand, and one part fine pump-sand.

As to the general scheme of which the interceptor is an important item, only an engineer familiar with the drainage problems of some older cities can appreciate the good fortune of Vancouver and district in securing a complete general plan of drainage and sewerage so early in its history. And perhaps only an engineer who, like the writer, has devoted some nine years to its development can fully appreciate the massive grasp and skill behind Mr. Lea's great system of drainage for Vancouver and the Burrard Peninsula.

Chas. Brakenridge, M.E.I.C.[4]

The formation of the Vancouver and Districts Joint Sewerage and Drainage Board reflects great credit on the wisdom and foresight of the public men and officials in office at the time this scheme was conceived. The unfortunate position in which the old city of Vancouver was placed, with rapidly developing areas on the lower slopes adjacent to tidewater urgently requiring the extension of sewerage and drainage facilities and with sparsely developed lands on the higher levels tributary to the same drainage outlets but located in adjoining municipalities, drew attention forcibly to the imperative need of combined action.

The Board is responsible for the provision of trunk sewers and drains for all drainage areas of 400 acres or over, while the member municipalities retain the obligation to provide their own facilities for drainage areas of lesser extent than 400 acres, as well as for all lateral sewers, drains, and property connections.

In the final report submitted by Mr. R. S. Lea, the adoption of the separate system was strongly urged for the area tributary to English bay, notwithstanding the fact that a considerable portion of this area had already been sewered on the combined system. Mr. Lea recommended that the existing sewered area should be rigorously confined to its then present limits, and that any new construction should be carried out on the separate system.

In the preliminary design for an interceptor which was advanced in the Lea report, it was proposed to provide for storm water from those areas already sewered on the

(4) City Engineer, Vancouver, B.C.

combined system up to about one-quarter inch per hour; and the point was strongly stressed by Mr. Lea that unless the balance of the area to be made tributary to the interceptor was sewered on the separate system, there would be grave danger of pollution in the waters adjacent to the foreshore and bathing beaches.

At the time the Lea report was submitted, the limits of the city of Vancouver in the area tributary to the interceptor only extended as far south as 16th avenue, the balance of the territory to the south being within the confines of the municipality of Point Grey. This municipality and the adjacent one to the east, South Vancouver, were not amalgamated with the old city of Vancouver, till the beginning of 1929.

Both the old city officials and those of the Point Grey municipality were favourably disposed to the adoption of a combined system of sewerage for the area tributary to this interceptor; and in a report submitted to the provincial government at the time of the passing of the act by two independent engineers, Messrs. C. H. Rust and R. H. Thompson, it was pointed out that the danger of sewage pollution of the foreshore and beaches had possibly been over-estimated, and the need for adoption of the separate system unduly stressed. Subsequently a resolution was passed by the Sewerage Board and approved by the provincial government, substituting a combined system for the separate one advocated for this area; and the further development of sewerage facilities has consequently been carried out on the combined system.

The experience gained in this city seems to be somewhat at variance with some of the arguments generally advanced in favour of the adoption of the separate system, particularly in regard to the possibility of delaying the installation of storm drains until some time after that of sanitary sewers. It has been found here that in the development of new areas there has often been a greater demand for the early provision of facilities to take care of storm water in districts where household septic tanks are giving reasonably satisfactory service, and where sanitary sewers are not therefore immediately required. It has been the experience in these new districts that more trouble and inconvenience arise from the flooding of low-lying areas and basements, due to the lack of storm water carriers, than from the want of sanitary sewers; while the development of street improvements has often been retarded from the same cause.

Owing to the large areas remaining between the interceptor and the foreshore below a level that could be drained to the interceptor the sewage from such areas must continue to discharge into waters which partially reach the bathing beaches until pumping stations can be installed and the sewage raised to the interceptor level. In this connection it may be pointed out that the city acceded somewhat reluctantly to the proposal to move the head of the interceptor one block further south on Cambie street, as a semi-trunk sewer had been in existence for several years on 7th avenue, discharging into Cambie street trunk at that point. But it was finally arranged that in order to gain an additional 14 feet of head, the interceptor should commence at 8th avenue and Cambie street and this necessitated the construction of a relief sewer on 8th avenue for a distance of approximately 2,750 feet east.

It should be noted that the city of Vancouver was vitally concerned with any economies that could be effected in the construction of this interceptor, as the city's share of the capital cost amounted to approximately 98 per cent of the total amount. The method of assessing the member municipalities of the Sewerage Board finally adopted is to distribute 30 per cent of the total cost of any particular trunk sewer project amongst the member municipalities in the ratio of the total assessed value of the land in the respective municipalities, while the remaining 70 per cent of the cost is distributed according to the relative total assessed value of the lands actually benefited by any such sewer or project in the particular drainage district, irrespective of municipal boundaries. This method of assessment was provided in an amendment to the original act as the result of an appeal lodged by the old city of Vancouver against the first assessment, which was based on a strictly legal interpretation of the original act. The revised method was based on the assumption that the general health of the community might be considered to be benefited to the extent of 30 per cent of the cost of any particular trunk sewer or project.

One of the most interesting features of the paper is that part dealing with the submerged outfall. Great credit was reflected on the engineers responsible for the original report in 1912-13 when it was finally decided some fifteen years later, after spending an additional two years in further extensive investigations and studies, to locate the outfall in substantial accordance with the original plan notwithstanding the fact that considerable development of public bathing beaches had taken place in the vicinity in the meantime.

It may be of interest to point out that before finally selecting Imperial street as the most suitable point for the outfall of the English bay interceptor, Mr. Lea gave serious consideration to the possibility of carrying the interceptor in the opposite direction to that ultimately selected, and fixing the site of the outfall at the First Narrows of Burrard Inlet, where, as it was stated, from the dispersion point of view the ideal condition of discharge existed. But the possibility of a dam being constructed at some future time at the Second Narrows was undoubtedly an adverse influence; and the original report of Mr. Lea finally set forth that "although the actual cost of carrying an outfall there (at the First Narrows) is not prohibitive, it was considered that equally good results could be obtained by discharging at a more accessible point."

The decision to restrict the capacity of the submerged outfall to what was necessary to convey the dry weather flow during the periods of extreme high tides seems to have been well warranted in view of all the circumstances, including the fact of the very infrequent intervals during which the overflow will be likely to discharge during the bathing season. The storm outlets at Balaclava and Maple streets are themselves provided with smaller submerged outfalls discharging below low water; and these will further tend to minimize the disposition of sewage along the foreshore.

The location of a plant in the city equipped to manufacture pre-cast pipe made by the Hume centrifugal process facilitated the adoption of this type of concrete pipe for the submerged outfall. The closeness of grain which marks the Hume pipe in the smaller sizes, so well shown under the microscope, and which, as experiments with acetic acid extending over eighteen months in the city laboratory show, is accompanied by a noteworthy increase of resistance to attack by agents like the carbon dioxide dissolved in the sea-water or in ordinary ground-water, is not so marked in the large pipe sizes, owing to the slower spin and the lesser centrifugal effect during manufacture. There is still, however, an appreciably greater resistance to the accelerated attack by acetic acid of 2 per cent strength on the large sizes of Hume pipe as compared with wet mix pipes of the same size which had been cast without the spinning.

The vital importance of obtaining both good mechanical contact and water-tightness in the joints of the submerged outfall appears to have been fully recognized, not only in the design of the joints, but also in the care taken to secure accurate grade and alignment in the pipe-cradle before the pipe-lengths were placed in position. It is equally reassuring to learn that such good results were obtained with the Sika compound used in caulking the pipe-joints. Engineers will follow with interest the service record of this important installation of pre-cast pipe and its jointing material. But the care which seems to have been exercised throughout in laying and jointing, taken in conjunction with the prompt backfilling of the trench and the numerous and substantial pile-bents, give all reasonable assurance of security at the joints. The thickness of the pipe-shell, 7½ inches, ought to be sufficient to guarantee that the pipe will have long life so far as chemical attack is concerned.

It is certainly disturbing to learn that the teredos were capable of working so much havoc in such a short space of time as was experienced in this case; and engineers are indebted to the writer of the paper for bringing the occurrence to their attention.

It is interesting, though in no way surprising, that total darkness exists at the bottom of English bay. The enormous quantity of fine silt carried down by the Fraser river, which has its origin in the wide and deep masses of glacial material that were deposited in its broad valley during the Ice Age, fully accounts for the darkness at the bottom of the bay, as can be understood by a comparison of the colour of the water in the bay with that from the open sea, especially during the periods of high water in the Fraser river.

G. M. Gilbert, A.M.E.I.C.[5] (Author's Reply.)

There is nothing further to be added to the discussion submitted by Mr. J. M. Begg. He goes more fully into some of the features of design which were mentioned in the paper.

The discussion submitted by Mr. Brakenridge adds considerably to the knowledge of this project and stresses points which were not fully developed in the paper.

(5) Acting Engineer and Superintendent, Vancouver and District Joint Sewerage and Drainage Board, Vancouver, B.C.

Mr. Creer's discussion might be analyzed. He states that in time the bathing beaches along the south shore of English bay will have to be abandoned or provision made for extending the outfalls. He also questions the location of the outlet off Imperial street. The answer to both these objections is that the present outlet is only temporary, provision having been made for the ultimate outlet some 2,500 feet further off shore.

Mr. Creer mentions the possibility that an interceptor may have to be carried in the opposite direction syphoning under False creek to the neighbourhood of Prospect Point to discharge into the high velocity currents there. This is a very remote possibility. A much more likely development will be the extension of the interceptor through the University Endowment Lands to discharge into the Gulf of Georgia somewhere near Point Grey. The interceptor was built with this possible development in mind and the extension westward would continue from the corner of 1st avenue and Imperial street, although the present outfall would no doubt always be in use to carry part of the flow.

While it may be possible to flush grit out of the short outfalls it would only be asking for trouble to allow grit to settle in the long outfall off Imperial street. In fact, as pointed out in the paper, one of the cardinal points of design was that no grit should be allowed to enter the submarine pipe.

The argument of "Contract vs. Day Labour" is a matter of opinion and one in which circumstances play so large a part that it is impossible to make a definite statement one way or the other.

The Sika compound has not been analyzed. The joint shown in Fig. 1 was especially designed to give a butt joint and yet permit of closure. The action of the compound is to increase the hydration and prevent the efflorescence always present in Portland cement. Number 3 Sika, the one used, is a liquid used for making a rapid-setting concrete, and for surfacing floors where an extremely hard and impervious and smooth finish is required. It is largely used for pipe jointing under water.

Streamlining

J. J. Green, A.R.C.Sc., Ph.D.,
National Research Laboratories, Ottawa, Ont.

Paper presented before the Ottawa Branch of The Engineering Institute of Canada, October 18th, 1934.

One of the most vital questions to the engineer is efficiency. In the forward march of applied science this factor becomes increasingly important.

Within the last twenty years the aeroplane has entered into the field of transportation, and the threat of competition has awakened the transport engineer to a realization of all the possibilities for improved efficiency that have been waiting for him ever since George Stephenson built the "Rocket."

The following notes refer to one of these possibilities, viz., the reduction of air resistance by streamlining.

When a body is moving through air or any other fluid, a variety of phenomena can be observed. In order to examine these phenomena in detail, we will travel with the body so that relative to ourselves it is at rest and the fluid is moving past. As the fluid meets the body, it becomes displaced by it and, in being compelled to flow around the body contour, its velocity becomes changed in regions close to the body, the effect being diminished with distance from the body.

Two types of resistance are encountered,—one due to the viscosity of the fluid arising from the frictional forces called into play by the relative motion of the body and the fluid adjacent to it, and the other due to the inertia of the fluid, involving its density and the impressed velocity changes, which give rise to variations of pressure around the contour of the body. These two types of resistance are usually referred to as the "skin friction" and the "form drag."

Suppose that our body is of cylindrical shape of say elliptic cross section and that we have a variety of instruments for examining the behaviour of the fluid. We observe that, depending on the velocity, there are two specific types of flow pattern. At extremely low velocities the flow is said to be streamline, taking place as it does along definite paths with respect to the body which are unchanging with time.

At "A" where the fluid impinges, the pressure on the body rises above the pressure in the remote fluid by an amount $\frac{1}{2}\rho V^2$, where ρ is the fluid density and V its velocity relative to the body, representing the kinetic energy in unit volume which is yielded up by the fluid arrested at "A." From stagnation at "A" the fluid is accelerated due to the constricting action of the body on the stream. The centrifugal tendency of the accelerating fluid to leave the curved surface causes the pressure to fall below the pressure in the remote fluid. From "B" to "C" the velocity is falling and the pressure rising, with the result that the pressure distribution around the cylinder is such as to give rise to a very small pressure resistance or form drag. The major portion of the resistance is composed of skin friction due to the body retarding the adjacent fluid layer through the mechanism of viscosity.

As the relative velocity V is increased, the fluid particles have an increasing tendency to fly off tangentially to the surface of the cylinder and the restraint provided by viscosity is insufficient to maintain this type of flow. At a critical velocity, depending on the shape and size of our body, the second type of flow sets in. On the forebody the flow resembles streamline flow, but the boundary layer between "A" and "B," the thin fluid layer in which the viscous forces between body and fluid are operative, now breaks away from the body and travels downstream. Since the inside of this layer has been retarded by friction over the body surface, a large velocity gradient exists across it, the fluid on the inside moving much more slowly than that on the outside edge. This causes the sheet of fluid to roll up into a vortex which travels downstream behind the cylinder. In this way a wake of vorticity is generated by the body, alternate vortices being shed from either side.*

With this second type of flow, the excess pressure at "A" is again $\frac{1}{2}\rho V^2$, falls to a minimum between "A" and "B," recovers slightly near "B," but remains below the pressure in the remote fluid over the remainder of the surface. This type of pressure distribution naturally results in a large form drag in comparison with which the skin friction is negligible.

It is evident that the breakaway of the flow depends very much on the sharpness of the turn it must make in order to adhere to the surface. By changing the body shape so that it converges gradually to a sharp tail, the breakaway of the flow is delayed and a wide wake with its low pressure is absent. This is the principle involved in streamlining which aims at maintaining always a type of flow similar to the first type discussed. A number of flow photographs have been published which show how streamlining reduces the width of the wake and induces the fluid to follow the body contour, and convincing numerical results can be quoted showing what enormous savings in resistance can be made on simple shapes such as the square and circular section by replacing them by streamlined sections.

Returning to the mechanism of the breakaway of the flow, the pressure distribution around the body is also a controlling factor. From "A" towards "B" the falling pressure urges the fluid of the boundary layer along in the general direction of flow, but having reached a minimum the pressure makes an effort to recover its former value with the result that the boundary layer meets a rising pressure which opposes its motion. This assisted by viscous forces slows it down so that a stagnation occurs and the fluid following on behind is forced to leave the surface.

Now two types of flow are possible within the boundary layer itself, viz., laminar and turbulent flow. In the former type, the motion takes place in definite layers and in the latter type there is an interchange of particles between adjacent layers. If the boundary layer flow changes from laminar to turbulent, some of the faster moving air outside gets mixed into the layer, bringing fresh stores of energy which enable the boundary layer to carry on for a greater distance against the adverse pressure gradient.

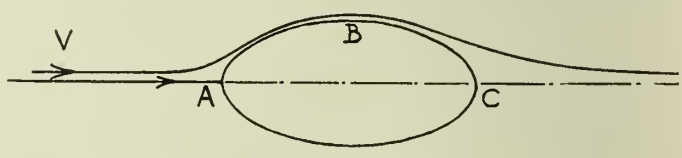

Fig. 1.

This delay of the breakaway reduces the width of the wake and thereby reduces the form resistance of the body. In the case of a sphere for instance roughening its surface actually reduces the drag due to this cause.

The action of a turbulent boundary layer in reducing drag is only operative in cases where the body drag is mainly form drag. In the case of a streamlined body, form drag has been much reduced and the resistance is due

*See Engineering Journal, June 1931, p. 357.

predominantly to skin friction. If now the boundary layer becomes turbulent, its increased energy content will give rise to greater intensity of friction between itself and the body. The increased skin friction will therefore appear as a larger measured total drag and this is found to be the case in practice.

In testing models of streamlined bodies such as airships in a wind tunnel, at some position along the body the boundary layer changes from laminar to turbulent. If the body is a "poor" streamlined shape, the transition occurs more towards the front, most of the boundary layer is turbulent and consequently the measured drag is higher than for a "good" streamlined shape of the same slenderness ratio.

Increasing the scale of the model or the wind speed causes the transition point to move forward on the model. It would appear therefore that due to the size of airships their boundary layers are almost certain to be wholly turbulent and a shape that is considered to be a "good" streamline will have as much skin friction drag as one that is considered a "poor" streamline.

This work on turbulent boundary layers is quite recent. The airships R-100 and R-101 carried concentrated loads at the nose and tail where mooring gear and control surfaces were located, yet due to their streamlined shapes a poor distribution of buoyancy existed which resulted in the presence of large bending moments in the framework. Had it been known at the time that a "poor" streamlined shape would have had as low an air resistance, a more cylindrical shape could have been used resulting not only in reduced bending moments but also in cheaper and more rapid construction due to the use of a large number of identical frames instead of all the frames being different in size as was the case.

For bodies on a less gigantic scale this need not worry us and good streamlined shapes are always desirable.

Having outlined the phenomena which attend the motion of bodies through fluids and having indicated how by controlling these phenomena by the principles of streamlining large savings in resistance can be obtained on simple shapes, existing transport vehicles will be considered to see what steps, if any, have been taken to utilize this knowledge in the quest for economy of power or the attainment of higher speeds.

Air travel is of course the youngest mode of transport and yet we find that the streamlined body is the foundation on which all aircraft design is built. Without streamlining,

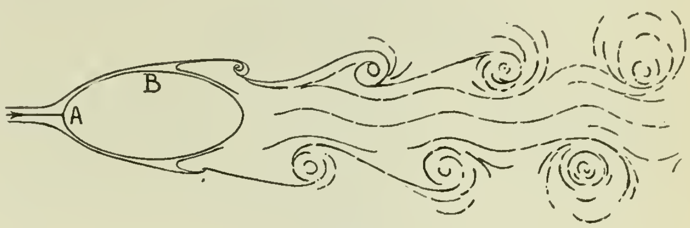

Fig. 2.

air transport would be impossible and for this reason the accumulation of all this knowledge concerning motion through fluids has been done mainly by groups of scientists primarily interested in the development of aircraft.

Turning to a consideration of land transport vehicles, we are at once impressed by the absence of streamlined types and a seemingly total disregard for the saving of power. In the case of steam locomotives, for instance, very little indeed has been done in the way of streamlining and yet the sharp corners and discontinuities of existing railway equipment must at high speeds absorb much power in creating unwanted air resistance.

In the last few years there has been a slight trend in certain directions towards streamlined types. Rail coaches and rail cars have been introduced in which great care has been lavished on the external design, which has in most cases been developed in wind tunnel. In the automobile industry a number of outstanding tests and attempts have been made at producing an efficient streamlined automobile.

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Public Works Tenders and Contracts

The programme of public works which is now being carried out by the Dominion and provincial governments is regarded as an effort to set the construction industry on its feet, and has met with general approval from this point of view.

The considerable expenditure which it involves will naturally be watched carefully by the public, who realize that at a difficult time like the present it is of special importance that the funds provided by the hard-pressed taxpayers shall be wisely and economically administered. It is evident that to attain this end the best possible methods should be followed in letting tenders and supervising the execution of contracts for public works.

Anything that can be done to improve present practice in this respect will meet with the willing support of the engineering profession. The many members of The Institute who are connected with the construction industry will therefore join the Council of The Institute in welcoming the request received last year from the Canadian Chamber of Commerce to furnish, for the information of its committee on Sound Public Finance, recommendations and comments as to the procedure desirable in dealing with tenders for public works, and the measures which should be taken to ensure satisfactory results from the contractors' work. In response to that request a valuable report on this subject has been prepared by a committee appointed by the Council and has been forwarded to the Chamber of Commerce for their information.

Council has directed its publication for the benefit of the membership at large and it will be found on page 131 of this issue of The Journal.

Members who are already familiar with this branch of engineering work will find that this clearly drawn and outspoken document deals with many points on which they have looked for information and in which improvement in the present general practice seems possible. Its publication will give to those who are not engaged in construction work some idea of the many precautions which are necessary in planning and executing public works if a fair deal is to be secured both for the public and the contractor, and if an adequate return is to be obtained when public money is expended in this manner.

The report will repay careful study and should be considered in relation to the Canadian Standard Forms of Construction Contract to which reference was made in our January issue.

It will be seen that the committee appointed by Council was thoroughly representative in its membership. In preparing their report they dealt first with the practice which is desirable as regards the calling of tenders, afterwards discussing the manner in which such tenders are dealt with, the way in which contracts should be interpreted, and a number of important points in connection with the inspection and final acceptance of public works carried out by contract.

Very properly, the committee has not confined its recommendations to technical questions, but has dealt with many considerations affecting the business relations of the parties concerned. In carrying out its task dogmatic methods of presentation have been successfully avoided; its recommendations are backed by reasoned argument throughout.

In dealing with such topics as have been placed before it there has naturally been room for difference of opinion on many points. It is therefore satisfactory to note that with one exception the committee's findings are unanimous. That point refers to the suggestion that tenders for public works of considerable magnitude and importance should only be asked from those contractors who have proved to the authorities that they have the equipment, personnel, experience and financial backing necessary to carry out the proposed work successfully. In this matter, however, one member holds that such selection might militate against the entry of new contractors into the field, even if they did possess the necessary resources to undertake the work.

The wide experience of the committee members has enabled them to suggest means of avoiding many sources of potential difficulty between the owner, the engineer and the contractor; for this reason their remarks on such topics as unbalanced tenders, tenders based on insufficient preliminary investigation of the site and its conditions, the formalities of procedure desirable in opening tenders and awarding contracts, and the thorny subject of contractors' guarantees for the signing of contracts and satisfactory performance of the work are worthy of close attention.

The concluding section of the report rightly draws attention to the way in which an irresponsible contractor may derive an unfair advantage if the specifications are not strictly drawn and closely adhered to. The committee's views on the importance of providing fully qualified engineers for the direct supervision of work in progress, and the desirability in many cases of the employment of outside consulting engineers and architects in the preparation of designs for important buildings, structures and bridges, are all timely and most commendable. While the report deals specifically with the question of public works contracts, many of its recommendations could be applied with advantage in contracts for the purchase of engineering equipment by public authorities.

The committee's work forms an admirable illustration of the fact that the successful outcome of an engineer's efforts does not depend on technical knowledge and ability alone. There must also be a continuous application of sound ethical and business principles throughout the preparation, execution and supervision of the undertaking.

Frederick Arthur Gaby, D.Sc., M.E.I.C.

President of The Engineering Institute of Canada

The long list of past-presidents of The Institute includes the names of men who have distinguished themselves in many branches of the profession. Their wide range of professional experience is in keeping with the diversity of interests of our members and the variety of engineering topics dealt with in our branch and Institute meetings. Looking back over the past five years the presidential chair has been occupied in succession by a a Federal Government engineer, responsible for construction work on a large scale; an officer of a great railway company, who is engaged in irrigation work and the development of natural resources in the west; a civil servant who is an authority on mining engineering and economic geology; an official of one of the provincial governments in charge of the water power resources of the province, and the chief engineer of one of our large bridge companies, versed in the design and fabrication of great steel structures.

The professional career of Dr. F. A. Gaby, who has been elected President for 1935, differs from all of these. For the past twenty years he has served as chief engineer of a publicly owned utility, which is equally remarkable for the magnitude of its operations and the excellence of the service it has rendered to the public. During this period the Hydro-Electric Power Commission of Ontario has expended some $300,000,000 on its various developments, which now carry a peak load of nearly 1,500,000 h.p. and supply electrical energy to more than 750 municipalities in the province. Dr. Gaby has thus had an outstanding career in thie field of engineering, and has established for himself an international reputation as an authority on problems of electrical supply, distribution and utilization.

He was born at Richmond Hill, Ontario, on March 26th, 1878, and graduated from the School of Practical Science, University of Toronto, receiving the degree of B.A.Sc. in 1903, and those of M.E. and E.E. in 1904.

FREDERICK ARTHUR GABY, D.Sc., M.E.I.C.

Following graduation Dr. Gaby became erecting engineer with the Canadian General Electric Company on the Nova Scotia Steel and Coal Company work at Sydney Mines. The next two years found him employed in a similar capacity with the Toronto-Niagara Company, and in 1906 he became chief assistant electrical engineer at the Pointe du Bois power plant on the Winnipeg river. Dr. Gaby joined the service of the Hydro-Electric Power Commission of Ontario in 1907, and acted in the capacity of assistant chief engineer until 1912, when he became chief engineer of the Commission, later acting also as chief executive officer.

Dr. Gaby in 1924 was honoured by the University of Toronto, receiving the degree of Doctor of Science as a recognition of his outstanding work in the field of hydro-electric power engineering in Canada.

Early in 1934, owing to a change in government in the province of Ontario, Dr. Gaby severed his connection with the Hydro-Electric Power Commission of Ontario, and became consulting engineer with Noranda Mines Limited. Later in the year he was appointed assistant to the president of the Canadian Pacific Railway Company, with headquarters in Montreal, and at the same time assumed the duties of vice-president of the Seigniory Club Association of Montebello.

Dr. Gaby became a Member of The Engineering Institute of Canada on February 25th, 1919.

He is a member of many national and international societies, including the American Institute of Electrical Engineers, the Institution of Electrical Engineers (Great Britain), the American Society of Civil Engineers, the American Society of Mechanical Engineers, and is a Fellow of the Royal Society of Arts.

The choice of Dr. Gaby as President for the ensuing year forms a noteworthy recognition of the importance of power engineering among the services through which engineers contribute to the working of the modern state.

Address of the Retiring President

F. P. Shearwood, M.E.I.C.

STRUCTURAL ENGINEERING

Delivered before the Forty-Ninth Annual General Meeting of The Engineering Institute of Canada, Toronto, Ontario. February 7th, 1935.

Before delivering to you the customary Presidential address in the usual formal manner, I want to express my sincere thanks for the hospitable reception given to me by the members of every Branch of The Engineering Institute which I visited throughout Canada.

This kindly hospitality transformed my responsibilities and duties into a pleasure, and it was a gratification to me to find everywhere the eager and vigorous enthusiasm for the well-being and progress of The Institute.

During the year in which I have had the honour of holding the office of President of your Institute, I have been more and more impressed with the fact that The Engineering Institute of Canada is a body which, by its very nature, generates loyalty to the ideals for which it was originally founded. It is true that time and energy have been given to such secondary matters as the methods of our administration, but the general feeling is that the voluntary interchange of knowledge, to which we give of our professional best, is the main characteristic which commands a loyalty and devotion such as no coercive or compulsory organization could beget or develop.

In addition to this, I have observed that the character of the aggregate of our members is determined by the character of the individual. There is expected from each member a zealous study of his own particular line of engineering, and there is also demanded from each individual student a modest effort to transmit to his fellow engineers the ideas and benefits gained from his investigations.

For this reason I venture to address you, not on the methods of conducting the affairs of The Institute or the law and order involved in its temporal affairs, not on the whole vast subject of engineering with all the ramifications which our profession includes, but on the detached branch of structural engineering, a subject in the study of which I have spent practically all my working time for nearly half a century.

Structural engineering, and particularly that which has to do with metal structures, has developed greatly during the last fifty years, and it is interesting to review the trend of this development, not only for the sake of showing the progress, but also to detect or suggest defects or exaggerations which may have crept into design (or rather into the control of design), and to point to lessons to be gained from existing structures, and from those which are now obsolete.

Bridges formed by far the greatest part of structural designing in iron and steel during the latter part of the last century. Considering only Canadian bridges we find that in the year of Queen Victoria's Jubilee steel was beginning to replace wrought iron. Canadian railways then had many different types of metal bridges on their roads. The Grand Trunk Railway and the Intercolonial Railway had bridges of English design which were mostly multiple lattice girders, plate girders and box girders. The most notable of these was the old Victoria bridge, at Montreal, a box type of continuous plate girder, having spans of 250 and 340 feet. It was remarkable not only on account of its long service but even more so because of many features in its construction which might be cited in proving the extravagances of modern designing. The lattice girders with multiple web system of flats and single angles and T-shaped chords which were in service on the Intercolonial main line until 1910 and 1911, and since then have been transferred to highway crossings, evidence the fact that many of the limitations and restrictions of modern designing are unnecessarily severe.

The Canadian Pacific Railway, which was built during the eighties, generally used for long spans the pin and link type of truss, which was very popular at that time. These structures presented a curious mixture of strict conformity to theoretical requirements and flagrant neglect of them. Pin joints were favoured on account of the fact that the members were concentrically grouped and free to turn, while riveted connections were avoided because the fixedness of their joints might induce dangerous secondary strains. On the pin-connected bridges, while their main truss members were concentrically grouped, most horrible eccentric connections were used for assembling all other parts. Perhaps the main reason for the popularity of the pin and link type of construction was not so much the claim of truly articulated joints, but rather that they were easy and cheap to erect. In those days all field riveting was done by hand riveters. This was an expensive process and it was often very difficult to obtain good riveting. Pin-connected spans are now seldom used for new bridges, partly on account of the cheapening of riveted members and their connections as compared with eye bars and pin joints, but more because experience has proved that the riveted truss is the stiffer and that no harm has resulted from the rigidity or fixedness of their joints. Then too the many defects in the design of the pin-connected span bracing and details have been recognized. The old fears of secondary stressing from non-articulated joints have largely disappeared, partly because scientific theoretical calculations prove them to be relatively small, and partly because practical experience shows no undesirable effects.

For railway bridges the present practice is to use rolled beams or plate girders for as long spans as can be fabricated and erected economically. Riveted trusses are used for all medium and long spans, although pin and link construction is occasionally favoured by some designers and fabricators for the longer spans.

For highway bridges, the practice is very much the same as that used for the railways, but trusses are used for shorter spans, owing to the restrictions specified for the thickness of the web plate. This makes plate girder construction heavy and expensive for the comparatively light loadings. The latest tendency is to lengthen the spans of long highway bridges and use the suspension type of bridge, while for the shorter spans the use of light welded steel frames encased in concrete has begun to replace rolled beams and rod reinforced concrete.

Until recent years continuous and other frames which are generally termed indeterminate structures, were rather studiously avoided, principally on account of the uncertainty of the reactions and of the difficulty of computing the stresses. Today, partly because of the superior calculating knowledge of the structural engineers and partly because the benefits of continuity are realized, they are beginning to be more frequently used.

Most of the highway bridges which were built thirty or more years ago were of extraordinary lightness. This was due to the very keen competition between the fabricating shops and the practical absence of any independent engineering check on their designs. The main material, the details and the connections of these old bridges outraged nearly all of the restrictions and limitations demanded by modern specifications, yet practically none of these bridges ever failed, even under the trials of overloading and lack of maintenance; but the lessons which should have been learned from their performances have been sadly ignored.

Most of the earlier bridges were designed by the fabricators and the contract for building them was awarded to the lowest tender, irrespective of quality. Competition (that curse of good engineering and of fair trade) became so keen that all means were used to reduce the costs and therefore designing became a science of reducing the weight of metal to a minimum. The factor of safety was therefore encroached upon so much, through the ignorance and nerve of the bidders, that a demand arose for some means to force bidders to keep within some recognized boundary. This resulted in the issue of standard specifications which were written mainly to prevent a tenderer from cutting down the factor of safety and thus obtaining a low bid.

The early standard specifications controlled only the main material and workmanship. It was soon found that the secondary parts and details could be cut so as to make reductions in the costs at the expense of quality, and so the specifications were amplified to control and restrict practically every part of the structure, while designing became largely a matter of following the letter of the specification. Subsequently designing deteriorated into a computer's task instead of developing the engineer's art. The arbitrary application of these specification rules had led to a demand or fad for stresses to be computed to the exact kip, and material provided to meet an exact definitely specified unit stress. Then followed a craving for so-called determinate structures with exact figured stresses, even when these were based on conjectural assumptions as to the amount and condition of loading. All this has tended to give designers an extravagant faith in figured stresses and in the unlimited and blind application of Hooke's Law. It has also induced a mania for complicated stress analysis, while conditions and straining of the materials during fabrication, erection and service are largely overlooked. The rigid application of Hooke's Law, the limitation of straining to a factor of the elastic limit of the material, the assumption of uniformity in the initial state of all materials, the frequency, severity and likelihood of the loading are all assumed to conform exactly to the basis of the specification, which of course they do not; and yet the specifications are made the prime and often the only considerations in proportioning a structure.

Standard specifications which so completely control every part and detail of modern steel bridges have tended to relieve designers from a sense of responsibility, but have also restricted ingenuity and have prevented the use of mature judgment based on the lessons to be gained from existing structures. Competitive designing has degenerated into a science of fulfilling the demands of a specification most cheaply, rather than of producing the best structure.

The question arises as to whether the science of designing framed structures does not rely upon computations which are based on arbitrary assumptions to too great an extent, instead of allowing engineering judgment based on practical experience to modify and adjust the proportioning of material and arrangement of details to the estimated demands of the forces to be resisted and the stability required.

If the designs and details of many of the old bridges are examined, they will be found to transgress very seriously the requirements of modern standard specifications. Yet no harm has resulted. Such features as the bracing of the chords of pony trusses with T-shaped sections, the thickness of flange, cover and tie plates and the thickness of outstanding legs of angles are constantly found to have conflicted with modern standard specification requirements. The omission of stiffeners on thin plate girder webs, the size and spacing of lacing bars, the slenderness of secondary compression members and compression joints which rely on abutting ends, are other matters in which past experience proves that slavery to specifications has prevented proper economy and balanced strength. The specifications with their arbitrary limitations and restrictions prevent a designer modifying the shape and make up of a member according to the character and conditions of the service, and often lead to extravagance and abnormality.

The conventional or specified practice of calling for a system of bracing to be designed to resist a specified wind force, and relying on it also to serve efficiently in stiffening and stabilizing the structure, is unscientific and often ineffective. The study of many of the old bridges, especially those of the pin and link type, with their inefficient systems of bracing, tends to prove that there are other paths of resistance, besides their lateral systems, which are strained by the horizontal forces and which aid in stabilizing the span and its individual members. This fact should be more fully realized and the structure should be designed accordingly.

The stabilizing of a structure as a whole and of its individual compression members and joints is a problem separate from the resisting of the wind force, and while a common resistance may often suffice, it is important to visualize the two as separate problems.

Lack of proper stability of the whole structure, or of the individual parts, or of the joints has been the cause of a large proportion of the rare failures in steel construction and includes some of the most notable cases.

The habit of treating a strain as a stress in all conditions of designing steelwork has prevented the full utilization of the ductility of steel. This property is greater, far more reliable and more uniform in steel than it is in any other structural material, and yet the use of it is most strictly guarded against. A fuller and more confident appreciation of the ductility of steel should justify a rational and intelligent use of this valuable property.

The rigid practice of treating a strain as a stress in strict accordance with Hooke's Law for all conditions and ranges of service when designing steelwork, has led to erroneous estimations of the real safety or strength of many structures, especially those having more than one path of resistance. Numerous cases exist of steel structures which have had some member or part distorted by overloading, abuse or secondary distortion, but on account of the ductile properties of the material, the excess strain has been absorbed by permanent distortion; or, the deformation has brought less strained paths to take an increased participation in the required resistance, without impairing the combined strength of the structure. Moreover, it is conceded that during the fabrication of the steelwork, this ductility is and must be constantly used, without assuming any reduction in the strength of the steel.

These evidences and the facts that the stress-strain curve of steel deviates strongly from a straight line after it passes the elastic limit, and that in most of the steels used for framed structures there is a large margin of strain between the elastic limit and the ultimate, should indicate that when the stresses do not alternate excessively, a large amount of redistribution of stress in frames with multiple systems can take place before one path of resistance is in danger, and that secondary distortion can generally be safely neutralized. The greater appreciation and visualization of the possible elastic and permanent deformation in structures should tend to the realization of the many inconsistencies in conventional designs. A close study of almost any riveted connection will show many local eccentricities which are neglected in our calculations. Most important of all, this appreciation might make us more careful in avoiding relative planes of weakness, or sudden alterations in sections, which interfere with the even flow of the stresses, particularly at or near points of maximum secondary distortion.

Turning now to the fabrication of steel structures, it may be noted that until quite recently improvements were in the nature of development rather than of radical change.

The advent and recent use of modern welding and the cutting torch are now bringing about a real change in the whole science and art of steel fabrication, and in its design. These changes are, perhaps, fulfilling the dream of many a designer of being able to join the component parts of a structure together without having to pierce the material with holes for rivets, bolts or pins, and being able to use less clumsy and indirect details than connection angles and similar devices.

Electric arc and gas welding, although still presenting many problems to be solved, appears to be destined to wholly, or at least very greatly, replace riveted methods of steel construction, while the quality of the work of the cutting torch is being improved so much by the use of automatic machines and manual skill that it is rapidly replacing shears, saws and other cutting apparatus, and enabling structural steel to be fabricated in a vastly different manner.

Investigation, testing and experience is proving that the distortion from burning and welding on thin material when correctly performed will in many cases leave no significant loss of strength or dangerous brittleness in the material. The engineer is particularly concerned in these latest tools of construction, because progress must demand their adoption if they prove superior, but it is equally certain that they must be used with far more scientific control than the older methods, since they require all superintendence and even some portion of the operation to be undertaken by trained engineers with approved appliances and highly qualified operators.

The subject of æsthetics too has been sadly neglected, especially in steel bridges. This condition is principally due to the fact that price is generally the only consideration when the design is made and the contract awarded for structural steel. Unsightliness has also been caused to a large extent by the restrictions and peremptory demands of standard specifications, and by illogical prejudices.

Beautiful structures can be designed in steel and will, no doubt, materialize in the future. Even in the present day more beautiful outlines are being used and evidence is not wanting to prove that the designers are departing from the angular and over-braced frames of the last half century. They are now adopting the more pleasing forms of the arch, the suspension and the continuous span.

In conclusion the question arises as to whether we have not treated all steel structures too much as a stress-sheet problem, balancing computed stresses which are based on assumed loadings with arbitrarily applied limitations, instead of proportioning the structure as a whole to meet the conditions to which it will be subjected.

If, in this brief review I have partaken of the nature of the critic, it is not the criticism of disparagement or destruction. On the contrary, it is to me a very hopeful sign that there are, throughout Canada, striking examples of steel construction which yield to none in their excellence, and which are designed by Canadian engineers. These examples testify that there is within the membership of our own Institute an ever growing class of efficient engineers, who are capable of designing these works, and who, by co-operation and consultation with fabricators, utilize in a proper way the available records of practical experience, in their effort to attain perfection.

It is to the growth of this class that we look for more freedom in designing and for the removal of undesirable restrictions, so necessary if price is to be the controlling consideration.

It may be that my remarks have been too closely concerned with bridge-building, too circumscribed and confined to the narrow line of steel construction, which incidentally has been to me an engrossing hobby, as well as a means of livelihood for many years; but you will have noticed that at least some of these observations are applicable to other lines of engineering.

Hampering restrictions, similar to those which I have described, have forced themselves on designers of many types of engineering construction, and on those whose work is exposed to the ruling of unyielding standardization.

I have treated the question from the point of view of the engineer engaged in steel construction, in the hope that I may induce representatives of other branches of engineering to dispense more information, derived from the riches of their own experience, and dedicated to the claims of, and the loyalty to, The Engineering Institute, which is the outward expression of our professional service to Canada.

Meetings of Council

A meeting of the Council of The Institute was held at the Royal York Hotel, Toronto, on Thursday, February 7th, 1935, at five o'clock p.m., with President F. A. Gaby, M.E.I.C., in the chair, and thirteen other members of Council present.

R. J. Durley, M.E.I.C., was re-appointed Secretary of The Institute and J. B. Challies, M.E.I.C., was re-appointed Treasurer.

The Finance Committee was re-appointed for the year 1935 under the chairmanship of P. L. Pratley, M.E.I.C., the membership being as follows:

P. L. Pratley, M.E.I.C., *Chairman.*
J. L. Busfield, M.E.I.C.
J. B. Challies, M.E.I.C.
A. Duperron, M.E.I.C.
F. Newell, M.E.I.C.

The chairmen of the other standing committees were appointed as follows, and asked to submit the names of the other members of their committees to the next meeting of Council:

Library and House Committee......E. A. Ryan, M.E.I.C.
Papers Committee..................C. S. L. Hertzberg, M.E.I.C.
Publication Committee.............H. Cimon, M.E.I.C.
Legislation Committee.............A. B. Crealock, A.M.E.I.C.

A report was presented from a special committee which had been appointed to make recommendations regarding the E.I.C. Catalogue, and in accordance therewith the continuation of the Catalogue for the ensuing year was approved.

Mr. Paulin pointed out that in connection with the three papers on "The Status of the Engineer," presented during the afternoon, the General Meeting had passed a resolution requesting the Council to take action to promote security and proper consideration for technically trained employees of the provincial civil services, and he urged that Council should do this without delay.

After considerable discussion, Mr. Paulin was appointed chairman of a committee to draft a brief on the subject to be forwarded to the various provincial governments, and he was requested to organize groups for the necessary supporting action in the different provinces, selecting the other members of his committee from members or councillors resident in the provincial capitals, the suggestion being that provincial legislation should be aimed at of a character similar to that now effective for the protection of Federal Civil Servants.

The Secretary was authorized to forward the thanks and appreciation of Council to the various committees and members who had co-operated in the arrangements for the Forty-Ninth Annual General and General Professional Meeting, and had contributed so greatly to its success.

Seven Students were admitted.

The Council rose at six thirty-five p.m.

A meeting of Council was held at Headquarters on Friday, February 22nd, 1935, at eight o'clock p.m., with President F. A. Gaby, M.E.I.C., in the chair, and nine other members of Council present.

A report was submitted by Dr. Lefebvre, chairman of a committee appointed by Council to submit recommendations for transmission to Major N. B. McLean, M.E.I.C., Chairman of the Interdepartmental Water Levels Board, who had requested an expression of opinion regarding water levels in the Montreal Harbour and the ship channel below Montreal. The committee's report suggested consideration of the possibility of a better control of the flow of the Ottawa river and a revision of the rules set up for the control of the discharge of Lake Superior. The report was accepted and approved, and the Secretary was directed to forward a copy to Major McLean, and to express the thanks of the Council to Dr. Lefebvre and his committee for their work.

Attention was drawn to the resolutions passed at the Annual Meeting in Toronto on February 7th, 1935, relative to the consolidation of the engineering profession in Canada, and the resulting appointment of a committee to develop the possibilities in this connection. Mr. Gordon McL. Pitts, A.M.E.I.C., the chairman, and Mr. R. F. Legget, A.M.E.I.C., the secretary of this committee, attended by invitation, and Mr. Pitts outlined for the information of Council the procedure which his committee proposed to follow.

It was noted that the committee intended to communicate with the branches of The Institute and the Associations of Professional Engineers with regard to this matter. Attention was drawn to the movements already in progress in Nova Scotia, New Brunswick, Quebec, Manitoba and Saskatchewan, looking to closer connection between the branches of The Institute and those provinces of the several Provincial Associations of Professional Engineers. Mr. Pitts explained that the pamphlet which he had prepared, and which his committee was circulating to corporate members of The Institute, was intended as a basis for discussion in the hope that it would elicit modifications or other proposals which would be an improvement on his own.

The following committees were appointed:

Papers Committee:
C. S. L. Hertzberg, M.E.I.C., *Chairman.*
I. M. Fraser, A.M.E.I.C.
C. C. Kirby, M.E.I.C.
C. K. S. Macdonnell, A.M.E.I.C.
A. B. Normandin, M.E.I.C.
J. J. Spence, A.M.E.I.C.
W. G. Swan, M.E.I.C.

Publication Committee:
H. Cimon, M.E.I.C., *Chairman.*
J. A. Duchastel, M.E.I.C.
A. A. MacDiarmid, M.E.I.C.
P. L. Pratley, M.E.I.C.
H. L. Trotter, M.E.I.C.

Legislation Committee:
A. B. Crealock, A.M.E.I.C., *Chairman.*
A. S. Gentles, M.E.I.C.
F. Newell, M.E.I.C.

In regard to the work of the committee appointed under the chairmanship of Mr. Paulin to communicate with the various provincial governments regarding legislation, the Secretary reported that the necessary letters had been forwarded to the members of Mr. Paulin's committee as follows:

H. L. Swan, M.E.I.C., Victoria, B.C.
R. S. L. Wilson, M.E.I.C., Edmonton, Alta.
D. A. R. McCannel, M.E.I.C., Regina, Sask.
F. G. Goodspeed, M.E.I.C., Winnipeg, Man.
A. B. Normandin, M.E.I.C., Quebec, Que.
H. S. Johnston, M.E.I.C., Halifax, N.S.
Alex. Gray, M.E.I.C., Saint John, N.B.

The report of the Finance Committee and the budget for the year 1935 were presented and approved.

Attention was drawn to the fact that so far The Institute had not been able to implement fully the terms of its agreement with the Institution of Electrical Engineers as regards the formation of Radio Sections, and Council approved the formation of a general committee under the chairmanship of Professor G. A. Wallace, A.M.E.I.C., to report as to further possibilities in this connection.

Discussion followed as to the general policy to be adopted in connection with members on the Non-Active List who owe for 1933.

The Secretary having pointed out that the five year period for which The Engineering Institute of Canada Prizes had been originally established had now terminated, it was unanimously resolved that these prizes be continued for a further period of five years.

The Secretary reported that in connection with the discussion on the western water problem which had taken place at the Annual General Meeting in Toronto, copies of the papers presented had been forwarded to the Prime Minister, the Minister of Agriculture, and other Ministers interested, and also to the Premiers of the prairie provinces, with an offer of co-operation on the part of the Council of The Institute.

The attention of these governmental authorities was drawn to the desirability of including an engineer in the membership of any commission or committees appointed to take action on the drought situation.

A letter was presented from Mr. G. A. Gaherty, M.E.I.C., commenting on the valuable information brought out in these papers, and suggesting that Council nominate a committee to follow up the work initiated in the symposium. Such a committee might collect and co-ordinate the relevant data, and might assist in the detailed field investigations which would no doubt be the function of some governmental body. The suggestion was heartily approved and it was resolved that Mr. Gaherty be asked to accept the chairmanship of such a committee.

Six resignations were accepted, a number of members were replaced on the active list, four members were placed on the non-active list, and several special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

Elections		*Transfers*	
Members	2	Assoc. Member to Member	5
Associate Member	1	Junior to Assoc. Member	5
Students admitted	2	Student to Assoc. Member	4
		Student to Junior	3

The Council rose at twelve fifty a.m.

Annual Fees

Members are reminded that a reduction of One Dollar is allowed on their annual fees if paid on or before March 31st of the current year. The date of mailing, as shown by the postmark on the envelope, is taken as the date of payment. This gives equal opportunity to members residing in all parts of the country.

The Forty-Ninth Annual General and General Professional Meeting

Convened at Headquarters, Montreal, January 24th, 1935, and adjourned to the Royal York Hotel, Toronto, on February 7th, 1935

The Forty-Ninth Annual General Meeting of The Engineering Institute of Canada commenced at Headquarters on Thursday, January twenty-fourth, nineteen hundred and thirty-five, at eight fifteen o'clock p.m., with President F. P. Shearwood, M.E.I.C., in the chair.

The Secretary having read the notice convening the meeting, the minutes of the Forty-Eighth Annual General Meeting were submitted, and on the motion of J. L. Busfield, M.E.I.C., seconded by R. H. Findlay, M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of H. W. B. Swabey, M.E.I.C., seconded by J. G. Hall, M.E.I.C., Messrs. A. Duperron, M.E.I.C., Fraser S. Keith, M.E.I.C., and Fred Newell, M.E.I.C., were appointed scrutineers to canvass the Officers' Ballot and report the result.

There being no other formal business, it was resolved, on the motion of M. D. Barclay, A.M.E.I.C., seconded by J. A. McCrory, M.E.I.C., that the meeting do adjourn to reconvene at the Royal York Hotel, Toronto, at ten o'clock a.m., on the seventh day of February, nineteen hundred and thirty-five.

Adjourned General and General Professional Meeting at the Royal York Hotel, Toronto

The adjourned meeting was called to order by President F. P. Shearwood, M.E.I.C., at ten a.m. on Thursday, February 7th, 1935. The Secretary having announced the receipt of a number of messages of regret and felicitation, submitted the membership of the Nominating Committee appointed to nominate the officers of The Institute for 1936 as follows:

Nominating Committee 1935

Chairman: L. F. Grant, M.E.I.C.

Branch	*Representative*
Halifax Branch	A. F. Dyer, A.M.E.I.C.
Cape Breton Branch	R. R. Moffatt, A.M.E.I.C.
Saint John Branch	J. N. Flood, A.M.E.I.C.
Moncton Branch	C. S. G. Rogers, A.M.E.I.C.
Saguenay Branch	A. W. Whitaker, A.M.E.I.C.
Quebec Branch	P. Methe, A.M.E.I.C.
St. Maurice Valley Branch	J. H. Fregeau, A.M.E.I.C.
Montreal Branch	H. G. Thompson, A.M.E.I.C.
Ottawa Branch	J. McLeish, M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	R. A. Low, A.M.E.I.C.
Toronto Branch	E. L. Cousins, M.E.I.C.
Hamilton Branch	J. R. Dunbar, A.M.E.I.C.
London Branch	H. A. McKay, A.M.E.I.C.
Niagara Peninsula Branch	C. G. Moon, A.M.E.I.C.
Border Cities Branch	S. E. McGorman, M.E.I.C.
Sault Ste. Marie Branch	A. H. Russell, A.M.E.I.C.
Lakehead Branch	
Winnipeg Branch	A. J. Taunton, A.M.E.I.C.
Saskatchewan Branch	P. C. Perry, A.M.E.I.C.
Lethbridge Branch	R. Livingstone, M.E.I.C.
Edmonton Branch	H. J. MacLeod, M.E.I.C.
Calgary Branch	H. W. Tooker, A.M.E.I.C.
Vancouver Branch	W. H. Powell, M.E.I.C.
Victoria Branch	J. N. Anderson, A.M.E.I.C.

Awards of Medals and Prizes

The Secretary announced the winners of the various prizes and medals of The Institute. The President stated that the formal presentation of these distinctions would take place at the Annual Dinner in the evening, and announced also that in the unavoidable absence through illness of Past-President R. A. Ross, he would be represented by his daughter, Miss Vernon Ross, who had kindly consented to receive the medal on her father's behalf.

The Sir John Kennedy Medal to Robert Alexander Ross, D.Sc., M.E.I.C., Consulting Engineer, Montreal, Past-President of The Institute.

The Gzowski Medal to W. H. Powell, M.E.I.C., Engineer, Greater Vancouver Water District, Vancouver, B.C., for his paper "The First Narrows Pressure Tunnel, Vancouver, B.C."

The Leonard Medal to D. E. Keeley, M.C.I.M.M., Mines Superintendent, McIntyre Porcupine Mines Ltd., Schumacher, Ont., for his paper "Guniting at the McIntyre Mine."

The Plummer Medal to F. E. Lathe, Director, Division of Research Information, National Research Council, Ottawa, for his paper "The Utilization of Magnesian Carbonates."

Students' and Juniors' Prizes

The John Galbraith Prize (Province of Ontario) to F. A. Masse, Jr.E.I.C., Assistant Chemist, Abitibi Power and Paper Company, Sault Ste. Marie, Ont., for his paper "A History of Paper Making."

The Phelps Johnson Prize (Province of Quebec—English) to C. B. Charlewood, S.E.I.C., Noranda Mines, Ltd., Noranda, Que., for his paper "Steam Distribution in the Newsprint Mill."

Report of Council and Report of Finance Committee

The Report of Council for 1934 was read by the Secretary, and in connection therewith the President drew attention to the number of prominent members of The Institute who had died during the year. As a token of respect a moment of silence was observed while those present stood in memory of the deceased members.

The report of the Finance Committee was presented by its chairman, P. L. Pratley, M.E.I.C., after which it was moved by Mr. Pratley, seconded by J. B. Challies, M.E.I.C., and resolved that the report of Council and the report of the Finance Committee be approved.

Reports of Committees

The report of the Membership Committee was presented by its chairman, D. C. Tennant, M.E.I.C., who concurred in the emphasis given in the report of Council to the necessity for activity as regards new members, after which, on the motion of Mr. Tennant, seconded by R. W. Boyle, M.E.I.C., it was resolved that the report of the Membership Committee be adopted.

The following committee reports, as published in The Journal for February 1935, were presented: Gzowski Medal Committee, Plummer Medal Committee, Leonard Medal Committee, Students' and Juniors' Prizes, Papers Committee, Publication Committee, Library and House Committee, E.I.C. Members of the Main Committee of the C.E.S.A., Committee on Relations with National Societies, Board of Examiners and Education and the Employment Service Bureau. On the motion of C. K. McLeod, A.M.E.I.C., seconded by J. A. McCrory, M.E.I.C., the reports of the above committees were adopted.

The report of the Committee on Unemployment was presented verbally by D. C. Tennant, M.E.I.C., who drew attention to the fact that information received from the branch unemployment committees pointed to a very definite general improvement in conditions of employment of members of The Institute. The adoption of the report was moved by Mr. Tennant, seconded by P. C. Perry, A.M.E.I.C., and carried.

Branch Reports

On the motion of L. F. Grant, M.E.I.C., seconded by H. A. Lumsden, M.E.I.C., it was resolved that the reports of the various branches be taken as read and accepted.

Entrance Fee

The President pointed out that Council's action in reducing the entrance fee from the specified amounts to $5.00 for all classes of members had been effective during 1934 as approved by the Annual Meeting in February 1934, and that Council now recommended that the policy be continued during the year 1935. On the motion of P. L. Pratley, M.E.I.C., seconded by F. Newell, M.E.I.C., it was resolved that for the current year the entrance fee be continued at the sum of $5.00.

Address of Retiring President

The President then gave his address on "Structural Engineering," which is printed in full on pages 144 to 146 of this issue of The Journal, and was received with marked attention.

Election of Officers

On the conclusion of the retiring President's Address the Secretary read the report of the scrutineers appointed to canvass the officers' ballot for 1935, and the officers named therein were declared duly elected as follows:

President	F. A. Gaby
Vice-Presidents:	
Zone A	E. V. Caton
Zone C	P. L. Pratley
Councillors:	
Halifax Branch	H. S. Johnston
Saint John Branch	C. A. Vandervoort
Saguenay Branch	G. H. Kirby
St. Maurice Valley Branch	B. Grandmont
Montreal Branch	A. Frigon
	E. A. Ryan
Ottawa Branch	E. W. Stedman
Kingston Branch	L. F. Goodwin
Toronto Branch	A. B. Crealock
London Branch	J. A. Vance
Border Cities Branch	C. G. R. Armstrong
Lakehead Branch	G. H. Burbidge
Saskatchewan Branch	S. Young
Edmonton Branch	H. R. Webb
Vancouver Branch	A. S. Wootton

Mr. Shearwood then welcomed Dr. Gaby to the Presidency and asked Past-President C. H. Mitchell, M.E.I.C., and Past-President Charles Camsell, M.E.I.C., to conduct the newly elected President to the chair. After this ceremony, in expressing appreciation of the honour done him, President Gaby said that he realized that many important problems faced The Institute at this time, especially those resulting from the period of depression, but he felt that with the sympathetic co-operation of the members he would be able to meet the responsibilities of the office of president. He regretted that in the past, owing to the stress of other work, he had not been able to take as active a part in the affairs of The Institute as he had desired, but he had been able to encourage those associated with him to participate in The Institute's work. He felt that the important questions before The Institute at the present time were, first, the search for a feasible method of consolidating the engineering profession in Canada; secondly, to enhance the value of The Institute to its members and to increase its membership, and finally to balance the budget so as to maintain The Institute in a sound financial condition.

On the conclusion of the President's remarks, on the motion of J. H. Hunter, M.E.I.C., seconded by S. F. Rutherford, A.M.E.I.C., it was unanimously resolved that a very hearty vote of thanks be accorded to the retiring President and members of Council in appreciation of the work they have done for The Institute during the past year.

On the motion of P. B. Motley, M.E.I.C., seconded by G. McL. Pitts, A.M.E.I.C., it was unanimously resolved that the thanks of The Institute be conveyed to the Toronto Branch in recognition of their hospitality and activity in connection with the holding of the Forty-Ninth Annual General and General Professional Meeting.

On the motion of W. E. Ross, A.M.E.I.C., seconded by J. A. Vance, A.M.E.I.C., it was unanimously resolved that a vote of thanks be tendered to the scrutineers for their services in preparing the report on the election of officers, and that the ballot papers be destroyed.

Consolidation of the Engineering Profession

The President remarked that the next item on the agenda was a discussion on the consolidation of the engineering profession, which would no doubt result from a number of resolutions and messages which had been sent in by branches of The Institute and others in regard to this question. The President also pointed out that if, as seemed possible, the discussion proved to be an extended one, it would be possible to have an adjourned meeting to continue it on Saturday morning. The Secretary then read resolutions and messages as follows:

Resolution from the Montreal Branch supporting any movement towards uniting the engineering organizations in each province and ultimately throughout the Dominion.

Resolution from the Ottawa Branch supporting the same object in identical terms.

Resolution from the Executive Committee of the Quebec Branch supporting any renewed efforts which may lead to organizing the Canadian engineering profession on similar lines to the legal, architectural or medical professions.

Telegram from the Executive Committee of the Border Cities Branch approving in principle the proposed consolidation of the engineering profession as set forth in Mr. Pitts' pamphlet.

Telegram from the Lethbridge Branch supporting the amalgamation of associations of professional engineers and The Engineering Institute of Canada, but opposing the method suggested by Mr. Pitts.

Resolution from the Association of Professional Engineers of the Province of New Brunswick recommending that every effort be made to advance the consolidation of The Engineering Institute of Canada and the professional associations of the various provinces.

It was further pointed out that in November last Council had received a resolution on the subject from the Halifax Branch favouring consolidation which had been published in The Journal of November 1934, page 505.

Gordon McL. Pitts, A.M.E.I.C., desired to preface the discussion by a broad motion which he hoped would express the sentiments of the meeting. He would move:

> "that The Engineering Institute of Canada in Annual Meeting assembled, hereby goes on record as being in favour of the consolidation of the engineering profession in Canada."

J. H. Hunter, M.E.I.C., suggested that in view of the number of members who might wish to contribute to the discussion a time limit on speeches should be set. The President inquired whether it was the wish of the meeting that a five-minute time limit should be set for any one individual to submit his views, and this was agreed to.

J. L. Busfield, M.E.I.C., drew attention to a pamphlet, prepared by Gordon McL. Pitts, A.M.E.I.C., entitled "Proposed Consolidation of The Engineering Profession in Canada," copies of which had been distributed to the members present, and inquired whether the term "the consolidation of the engineering profession in Canada" as used by Mr. Pitts, referred to the scheme outlined in the pamphlet in question.

Mr. Pitts replied that the scheme outlined in the pamphlet was intended as a basis for discussion, which he hoped would bring out better suggestions than any of those contained in the pamphlet.

Mr. Pitts' motion was seconded by J. L. Busfield, M.E.I.C.

Dr. O. O. Lefebvre, M.E.I.C., pointed out that the resolution merely asked for the acceptance of the broad principle of affiliation, and he believed there was no ground for diversity of opinion on that point. Differences of opinion would arise when it was necessary to discuss the methods by which the goal could be reached.

The motion was then put to the meeting and carried unanimously, with applause.

Mr. Pitts explained that he desired to make another motion with a view of giving ordinary members an opportunity to express their opinions on some of the details involved in any scheme for consolidation. He would move:

"That in view of the important question as to the policy of The Engineering Institute of Canada raised by the resolutions received from the branches relative to the consolidation of the engineering profession in Canada, and as it has direct bearing on the discussions which were not completed at the last annual meeting, and as the professional papers of this afternoon's session have direct bearing on the subject, therefore be it resolved that this annual general meeting of The Engineering Institute of Canada be reconvened at three thirty p.m. to-day for the discussion of the policy of The Institute with regard to the consolidation of the engineering profession in Canada."

Mr. Pitts remarked that the papers to be read in the afternoon would entail discussion which would have a direct bearing on the method of consolidation to be followed. His motion was intended to combine the discussion on the three papers on "The Status of the Engineer" with discussion on the consolidation of the engineering profession, so that the benefit of full discussion on both matters could be obtained at the same time. Mr. Pitts' motion was seconded by R. F. Legget, A.M.E.I.C.

F. A. Dallyn, M.E.I.C., remarked that in his opinion the principal difficulty was to define what was meant by the "profession of engineering." If, as a body, The Institute proposed to deal seriously with the resolutions that had been proposed, he felt that it would first be necessary to have a committee to decide what is a "professional engineer."

Mr. Busfield suggested that it was an unusual and possibly a conflicting procedure to carry on the discussions of a professional session and the debates of the Annual General Meeting at one and the same time. He felt that if the question of consolidation were discussed in the brief period left after the three papers of the afternoon had been read, there would not be time to get any conclusive result. He was therefore of opinion that the Council should again appoint a committee to study and investigate this question. Such a committee should take the opinions of everybody desiring to express them and take time to study their views. He believed that the matter should be placed in the hands of the Council.

General C. H. Mitchell, M.E.I.C., understood from Mr. Pitts' motion that it was intended to adjourn from this particular meeting and continue the discussion at three thirty p.m.

P. C. Perry, A.M.E.I.C., felt that it would be more satisfactory to carry on the discussion on Saturday morning, and he moved as an amendment to the motion of Mr. Pitts, that the Annual General Meeting be adjourned to Saturday morning. This amendment was seconded by Mr. Busfield.

T. C. Main, A.M.E.I.C., desired to point out, before voting took place, that the titles of the papers to be presented during the afternoon were "The Engineer in Industry," "The Engineer in Private Practice," and "The Engineer in the Public Service." He noted in the first one of these, by J. M. Oxley, M.E.I.C., the following statement: "The Engineering Institute of Canada has no provincial organization, and this question brings up again the necessity for close co-operation between the provincial bodies of engineers and The Institute." He thought therefore that irrespective of the discussion now taking place, the question of consolidation was bound to come up again in the afternoon.

Dr. R. W. Boyle, M.E.I.C., saw no objection to continuing the discussion of consolidation during the afternoon session, and his views were supported by Dr. O. O. Lefebvre, M.E.I.C., who hoped that the mover of the amendment would consent to withdraw it. Mr. Perry having expressed his willingness to do this, the amendment was withdrawn. The original resolution was then put and carried.

At the suggestion of General Mitchell it was decided to continue the discussion of the question of consolidation until the adjournment hour, and Mr. Busfield hoped that speakers would confine their remarks to discussing the manner in which consolidation could be effected.

G. Stead, M.E.I.C., drew attention to the communication from the Saint John Branch, and remarked that the membership of The Institute in New Brunswick was in close and friendly relations with the Professional Association of that province. Both bodies felt that the progress made so far by the Committee of Eight had not been satisfactory, and hoped that this meeting would bring about an improvement in this condition.

Mr. Gordon McL. Pitts asked the members present to give serious study to the pamphlet which he had prepared and of which copies were in members' hands. He pointed out that the scheme outlined a Dominion or central organization whose administrative officers would be chosen by the provincial engineering organizations. The functions of the provincial organizations would be professional in every sense, while the central body would concern itself with the dissemination of professional knowledge with regard to all branches of engineering, the publication of documents and of a professional journal, and the stimulation and support of the provincial organizations, particularly those provincial associations which had not yet attained their full development. He drew attention to the similar system which had been found to work well in the architectural profession and observed that when the Royal Architectural Institute of Canada was organized, it only had five provincial bodies as component societies. The remainder came in at a later stage.

He suggested that members should approach the very debatable question of the qualifications of membership in the spirit of co-operation and compromise.

Major L. F. Grant, M.E.I.C., was inclined to doubt whether there was any desire on the part of the professional associations to meet The Institute halfway. He feared that in any arrangement with the professional associations it would be up to The Institute to make the compromises of which Mr. Pitts had spoken.

He also drew attention to the position of The Institute's branches should a scheme like that proposed by Mr. Pitts come into effect. Major Grant had great respect and affection for The Engineering Institute to which he owed many friends, inspiration for his work, and additions to his professional knowledge, and he was not disposed to support the changes suggested until satisfied that The Institute's members in the smaller branches would get something better than they now have.

A. R. Chambers, M.E.I.C., speaking as a past-president of the Association of Professional Engineers of Nova Scotia, remarked that the idea of co-operation had always been before the Association in Nova Scotia and the Nova Scotia Branches of The Institute. Joint meetings had been held and at the present time the Provincial Association was looking towards an arrangement as regards Nova Scotia somewhat similar to that now advocated by Mr. Pitts.

C. H. Attwood, A.M.E.I.C., drew attention to the close connection between the Winnipeg Branch of The Institute and the Association of Professional Engineers of Manitoba, and believed that the recent proposal for joint control of those two bodies, which had not been accepted by the Council of the Professional Engineers of Manitoba, was still a live question.

Dr. R. W. Boyle, M.E.I.C., thought that before proceeding further with the discussion, some information should be available as to the progress, if any, which had been made by the Committee of Eight, representative of the Associations, which he understood was still engaged in the study of co-ordination of the efforts of the eight professional associations.

The secretary replied that the latest information available indicated that while the Committee of Eight had held a meeting in 1933, their progress was very slow, and seemed likely to continue so.

Dr. O. O. Lefebvre remarked that as regards the Committee of Eight, the expense (some $1,500 to $1,800) involved in organizing a meeting formed a great obstacle to their progress, particularly as it was difficult, if not impossible, to carry on the work by correspondence.

T. C. Main, A.M.E.I.C., desired to add to Mr. Attwood's remarks the information that at a recent annual meeting of the Association of Professional Engineers of Manitoba, the Association indicated their interest in the work of the Winnipeg Branch of The Institute by granting $150 to The Institute's Branch to carry on its technical meetings in Winnipeg.

Mr. Main's announcement was received with applause.

The morning session adjourned at 12.30 o'clock p.m.

The afternoon session convened at 3 o'clock p.m. under the chairmanship of J. B. Carswell, M.E.I.C., who observed that the afternoon discussion would be preceded by three papers on "The Status of The Engineer." These were presented in the following order: "The Engineer in the Public Service," by G. J. Desbarats, M.E.I.C., "The Engineer in Industry," by R. E. Smythe, A.M.E.I.C., and "The Engineer in Private Practice," by J. M. Oxley, M.E.I.C.

Mr. Carswell remarked that from some comments in Mr. Desbarats' paper he gathered that conditions in the provincial government services were not so satisfactory as regards pay and security of tenure as in the service of the Federal Government. He thought this point was worthy of discussion.

Mr. Gordon Pitts pointed out that in accordance with the resolution passed in the morning, this afternoon meeting, after the presentation of the three papers listed in the programme, should be regarded as a continuation of the Annual General Meeting.

R. F. Legget, A.M.E.I.C., remarked that in all three of the papers which had just been presented, attention was drawn to certain faults in present conditions as regards the status of the engineer. He regarded that status as the position of an individual in respect to his professional society and the public. All three papers therefore indicated the necessity for immediate action to improve the present position of the engineer.

The status of the engineer was at present imperfectly realized. For example, the qualifications for a position as director of the Bank of Canada as published, mentioned "lawyers, newspaper editors, doctors, locomotive engineers, printers and the like." Mr. Legget felt that the two main obstacles were, (1) trying to obtain uniformity of legislation before co-ordinating the work of the various associations and (2) attempting to get uniformity of ideas, that is, attempting to get all the provinces to think the same, before any move is made.

This subject had been under consideration for many years and had, in fact, been referred to by Sir Casimir Gzowski at a meeting of the Canadian Society of Civil Engineers in Toronto thirty-seven years ago. Sir Casimir had said that many members then present would be grey headed before all the provinces would agree to do the same thing.

Mr. Legget believed that the scheme proposed in the pamphlet did offer a possible way to attain results, and he hoped that before the meeting broke up some definite step forward would be taken.

The chairman thanked Mr. Legget for his contribution and pointed out that the discussion should primarily follow along the lines of the papers which had been presented. Mr. Carswell drew attention to the figures given by Colonel Smythe as regards the supply of young engineers in this country, and the effect of branch industries coming into Canada from the United States and elsewhere and bringing their own engineers with them. Colonel Smythe had suggested that The Institute should co-operate with the Dominion government in dealing with this situation.

W. E. Ross, A.M.E.I.C., pointed out that in the early days of the development of the electrical industry in Canada, this development went so fast that the supply of engineers was insufficient, hence they had to be imported.

He was struck with the disparity between the large number of engineering graduates as given by Colonel Smythe, amounting to over eleven thousand for the period which he had quoted, as compared with the membership of The Institute, roughly about four thousand.

Mr. H. C. Powell, as a member of the executive of the Ontario Vocational Guidance Association, stated that there was a great many misfits in engineering and that The Institute's co-operation would be valuable in overcoming this difficulty. The problem was, to give preference to engineering graduates without any injustice to the young men trained in the technical schools. This was now a very real difficulty in the province of Ontario.

Professor Haultain, M.E.I.C., remarked that no reference had been made to mining, which was one of the outstanding industries in Canada; many mining graduates were now earning $20,000 a year because of the high status they held in the industry.

F. W. Paulin, M.E.I.C., pointed out in connection with Mr. Desbarats' paper, that possibly beneficial results would follow if a resolution were sent to every provincial government asking them to adopt a system of promotion in the civil service similar to that which exists in the Dominion government. He would move that such a resolution be sent.

At the suggestion of the chairman, Mr. Paulin's motion was left with Mr. Desbarats and the chairman who were asked to frame the wording, and the motion was seconded by K. H. Smith, M.E.I.C., who thought that more recognition should be given to engineers who are public servants. The motion was then put and carried.

Mr. Paulin felt that the motion might have a broader effect if other associations such as the Royal Architectural Institute of Canada, and the Provincial Professional Associations were asked to join. He thought that the resolution might ask that the meeting might authorize the Council to send the resolution instead of the resolution coming from the meeting.

Mr. Busfield thought that instead of waiting for a joint resolution from a number of bodies, The Institute might go ahead with its own resolution and suggest to the other societies that they follow the motion up.

Dr. Lefebvre enquired as to the actual wording of the motion.

Mr. Paulin in reply stated that the motion was:

"That this meeting request the Council to draft a resolution which should be sent to the various provincial governments and to the Dominion government, asking that the provincial governments adopt the system which is in existence in the Dominion Civil Service in connection with appointment and the promotion of engineers in the service."

Dr. Lefebvre remarked that in adopting such a resolution the meeting was taking it for granted that a satisfactory system of promotion did not exist in any of the provinces. This was not the case, particularly in the province of Quebec, and he therefore thought that some distinction should be made, and it should not be assumed pointedly that the promotion system did not exist anywhere in the provinces.

J. M. R. Fairbairn, M.E.I.C., said that any resolution of this kind should emanate from the Council or at least should go to Council and be approved by Council before being sent out as coming from The Institute.

The chairman enquired whether there were any further points in connection with Mr. Oxley's paper on which discussion was desired.

E. M. Proctor, M.E.I.C., desired to lay stress on the necessity for co-operation between the engineer, the architect, and others connected with the design and carrying out of a project. He remarked that the success of the new entrance built into the city of Hamilton a few years ago was obtained by the close co-operation between himself as engineer, the architect, John M. Hill, and the landscape architect, Mr. Borgstrom. No one of the three alone would have been able to secure a result nearly as satisfactory as that obtained by the co-operation of the three.

The chairman drew attention to a further statement in Mr. Oxley's paper suggesting that in the case of errors due to the engineer's carelessness, and involving additional cost on the part of the owner, the engineer should assume responsibility, and pay for the costs involved.

Mr. Proctor agreed with Mr. Oxley in his opinion and Mr. Pitts pointed out that the province of Quebec enforces a five-year responsibility on both the engineer and the architect.

The chairman, as a contractor of twenty-five years' experience, wished that all engineers were of the same opinion as Mr. Proctor.

Colonel C. S. L. Hertzberg, M.E.I.C., did not agree with Mr. Oxley's opinion that the engineer should assume responsibility for mistakes, the contract being between the owner and the contractor. If the owner employed an incompetent engineer he should take the same responsibility as if he had employed an incompetent lawyer. It would be just as reasonable to make the lawyer pay the whole costs of a law suit arising from his faulty legal phrases as it would be to make an engineer pay the whole costs in a contract where a mistake had been made in the engineering advice.

Mr. Proctor replied that his point was not quite that taken by Colonel Hertzberg. The kind of error to which he had referred would be a foolish but serious one, such as would occur if an engineer laid out a sewer with an uphill instead of a downhill grade, so that the sewer would have to be relaid. Such extra cost he thought should be at the engineer's expense.

Clarence M. Pitts, A.M.E.I.C., remarked that at the morning meeting a very important question, the co-ordination of the engineering profession, had been considered, and a scheme for consolidation had been presented for discussion. The morning meeting had resolved that co-ordination is a desirable thing, but Mr. Pitts did not believe that the exact form of that co-ordination could be settled at this general meeting. He thought, however, that the meeting could leave the question in a position from which definite progress could be made, and in order that there might be active prosecution of the matter he moved:

"That it be resolved that the following committee be appointed with power to add to their number, to develop the possibilities of consolidation of the engineering profession in Canada and that they report their findings to Council and to the next annual meeting of The Institute, or to a special general meeting called for the purpose. This is the personnel of the committee: Dr. A. R. Decary, Past-President of The Institute, Mr. G. J. Desbarats, former Deputy Minister of the Department of National Defence, Mr. J. B. Challies, Treasurer of The Institute, Mr. R. F. Legget, representing the junior members of the profession, and Mr. Gordon Pitts."

Mr. Clarence Pitts further remarked that the personnel of the Committee now suggested was largely divorced from Council, and he made this proposal since in his experience the matter had been brought up to Council and had been shelved on every occasion. He felt therefore that the matter should not be part of the ordinary activities of the Councillors who are concerned with the ordinary working of The Institute, and that the suggested committee, highly qualified for this work, should be appointed so that real progress could be made before the next annual meeting.

Mr. Pitts' motion was seconded by Professor R. E. Jamieson, M.E.I.C.

Colonel Smythe pointed out that the members of the Committee were busy men and he thought that secretarial facilities should be provided for them at the expense of The Institute.

Mr. Clarence Pitts thanked Colonel Smythe for his suggestion, but believed that the Committee would be able to function satisfactorily without being subsidized.

Mr. K. H. Smith believed that any arrangement for the consolidation of the profession would not in itself fix the status of the engineer, as he believed that the status of the engineer must depend on his own individual abilities.

Colonel H. J. Lamb, M.E.I.C., hoped that Mr. Pitts' motion would bring some results and was in sympathy with it, but feared that it would take time to obtain the necessary concerted definite opinion from the different associations throughout the Dominion. Colonel Lamb recalled that in 1926 Professor Haultain and himself had spent some time in Montreal representing the Association of Professional Engineers of Ontario at a meeting of representatives of all the Provincial Professional Associations. That meeting worked on this very problem, as it was called to establish ways and means for the fullest co-operation of the provincial associations with The Institute. As a result of the work which followed this meeting there was a general feeling of agreement with the principles of consolidation, but that the efforts of the Associations themselves must first be co-ordinated. In his opinion there existed a feeling of opposition on the part of some members of the Associations which would have to be overcome, and he saw no way of doing this unless the fullest expressions of opinion were obtained from all the Associations, and the scheme finally threshed out over the table.

The chairman reminded the meeting of the terms of the motion as follows:

It has been moved and seconded that a committee be appointed with power to add to their number, to develop the possibilities of consolidation of the engineering profession in Canada, and that they report their findings to Council and to the next annual meeting of The Institute, or to a special general meeting called for the purpose.

General Mitchell enquired whether it was intended that the committee should report to the next annual meeting or would Council do so. He felt that there was danger of a divided responsibility. Mr. Gordon Pitts stated that the committee's responsibility was to report to the Council and report to the annual meeting.

Mr. Fairbairn observed that under the wording of the resolution the committee would report to Council and to the Annual Meeting. He thought this would result in a divided responsibility and in his opinion the committee should report to Council who would report to the Annual Meeting.

Mr. Gordon Pitts thought the membership would be wise to leave the wording as originally proposed. The Council was not appointing the Committee, but the Annual General Meeting was putting the responsibility on them, thus the work done by the Committee should be reported to Council and also be reported to the body laying the charge upon the Committee.

Mr. Fairbairn thought this arrangement open to objection, as it would appear that the Council of The Institute was being ignored by a meeting which was empowering a committee to report back to the meeting. He urged that the motion should direct the committee to report to the Annual Meeting through Council.

The chairman then suggested that two words should be added to the resolution so that it would read: "—and that they report their findings to Council and *through Council* to the next Annual General Meeting."

With this change in the wording the motion was put to the meeting and carried, with two members dissenting.

Colonel Lamb took it for granted that the Committee which had thus been appointed could count on the full support of Council in accomplishing if possible their objective. He thought it was clear that the meeting was very definitely in favour of the Committee's object.

The session adjourned at 5.35 o'clock p.m.

Social Functions

The chairman of the Toronto Branch, Colonel R. E. Smythe, A.M.E.I.C., presided at the luncheon held on February 7th, at which a cordial welcome on behalf of the Mayor of Toronto was extended by Controller Day. He was followed by Mr. J. B. Carswell of Hamilton, whose witty address outlined the subject of the "Status of the Engineer" which was scheduled for discussion at the afternoon session. The luncheon was well attended, and served as an admirable introduction to the various activities which followed.

In the evening the Annual Dinner of The Institute took place in the Concert Hall, President F. A. Gaby, M.E.I.C., in the chair. The prizes and medals of The Institute were presented by the Hon. Grote Stirling, M.E.I.C., Minister of National Defence, and a special interest was given to the presentation by the fact that in the unavoidable absence of Dr. R. A. Ross, M.E.I.C., the recipient of the Sir John Kennedy Medal, he was represented by his daughter, Miss Vernon Ross, who received the medal on her father's behalf.

The presentation of the prizes was followed by an address by Dr. A. S. Eve, C.B.E., F.R.S., Dean of the Faculty of Graduate Studies, McGill University, Montreal, many of whose touches of humour had an evident application to financial and social questions of the day.

The dinner was followed by a reception and dance, the members and guests being received by the President and Mrs. Gaby and by the chairman of the Toronto Branch and Mrs. Smythe.

One of the most interesting functions of the meeting was a tour of the Royal Ontario Museum, which was organized for the ladies. This was personally conducted by Professor C. T. Currelly, curator of the Museum, and the visiting ladies were afterwards entertained at tea at the Museum.

The function was greatly appreciated, as was also the ladies' theatre party held on the same evening. At the smoking concert a large audience greatly enjoyed the attractive programme which had been arranged by the entertaining committee under the chairmanship of Mr. W. E. Bonn, A.M.E.I.C.

Technical Sessions

At the professional sessions held on Friday, February 8th, the papers presented and discussed in the morning were the following:

In Hall D. under the chairmanship of H. V. Armstrong, A.M.E.I.C.:

"Research and Testing Work for the Hydro-Electric Power Commission of Ontario," by W. P. Dobson, M.E.I.C.

"Gaseous Conductor Lamps and Their Applications," by J. W. Bateman.

In the library, under the chairmanship of M. Barry Watson, A.M.E.I.C.:

"Simple Graphical Solution for Pressure Rise in Pipes and Pump Discharge Lines," by R. W. Angus, M.E.I.C.

"The Montreal Neurological Institute and Its Service Equipment," by F. J. Friedman, M.E.I.C., and C. P. Creighton, A.M.E.I.C.

In the Tudor Room under the chairmanship of H. A. Babcock, A.M.E.I.C.:

"The Toronto Waterworks Extensions, a General Description of the Scheme with Details of Some Outstanding Features," by William Storrie, M.E.I.C.

"Three Bascule Bridges of the Simple Trunnion Type," by H. W. Buzzell, A.M.E.I.C., and R. S. Eadie, A.M.E.I.C.

The professional sessions at this meeting were noteworthy in including two discussions of importance. The first, held on Thursday afternoon, dealt with the "Status of the Engineer," and was based on three papers as follows:

"The Engineer in Industry," by R. E. Smythe A.M.E.I.C.

"The Engineer in Private Practice," by J. M. Oxley, M.E.I.C.

"The Engineer in the Public Service," by G. J. Desbarats, C.M.G., M.E.I.C.

In these papers the salient points were first, the situation described by Col. Smythe, arising in Canada from the importation of young technically trained men from the United States and elsewhere, largely by organizations establishing branch plants in this country; second, a question raised by Mr. J. M. Oxley as to the necessity of complete co-operation and understanding between the engineer and the architect in undertakings involving the work of both professions, and thirdly, the fact, brought out by Mr. Desbarats, that the engineering officers in some of the provincial civil services are not so favourably treated as regards conditions of appointment and security of tenure as are their brethren in the Dominion Civil Service.

As a result of the discussion it was decided to ask Council to take immediate action with regard to the last named difficulty.

On the afternoon of Friday, February 8th, a large audience, to accommodate which it was necessary to adjourn to the Ball Room, took part in a discussion on "The Water Supply of the Prairie Provinces and its Bearing on their Economic Development" under the chairmanship of Past-President S. G. Porter, M.E.I.C. No less than eleven papers were presented on various phases of the subject as follows:

"Precipitation in the Prairie Provinces," by John Patterson.

"Surface Water Supply and Run-off of the Prairie Provinces," by J. T. Johnston, M.E.I.C.

"Water Conservation in the Prairie Provinces," by T. C. Main, A.M.E.I.C.

"The Surface Waters of the Canadian Prairies," by P. C. Perry, A.M.E.I.C.

"Rural Water Supply in Alberta," by W. Calder.

"Relationship of Geology to Soil Drifting in Southern Manitoba and Southern Saskatchewan," by W. A. Johnston and R. T. D. Wickenden.

"Some Possible Sources of Ground Water in Southern Saskatchewan," by R. T. D. Wickenden.

"Mineral Character of the Underground Waters in Southern Saskatchewan," by D. C. Maddox.

"Storage on the South Saskatchewan River," by Walter Blue, A.M.E.I.C.

"Tree Planting in Relation to Drought Control," by Norman M. Ross.

"Water Phases of the Drought Relief Programme of the United States Federal Emergency Relief Administration," by Lewis A. Jones.

The active discussion which followed threw additional light on nearly all these phases of the question.

It is intended to publish these papers and the discussion thereon in an early issue of The Journal.

Following the many activities of the first two days of the meeting, a considerable number of members remained for the morning of Saturday, February 9th, and took part in inspection trips to the following engineering works of interest:

New Armouries, Fleet Street.
The Bell Telephone Company, Elgin Building.
Laboratories of the Hydro-Electric Power Commission, Strachan Avenue.
Laboratories of the Ontario Research Foundation.
Water Purification Plant, Victoria Park.

The Annual Meeting Committee of the Toronto Branch are to be congratulated on the undoubted success of the meeting due so largely to their plans and efforts. A considerable proportion of the time usually taken up by purely technical papers was this year devoted to the consideration of topics of more general interest to the public and to members of the engineering profession, and this innovation met with general approval.

OBITUARIES

Robert Angus, M.E.I.C.

It is with deep regret that the death at London, Ontario, on January 16th, 1935, of Robert Angus, M.E.I.C., is placed on record.

Mr. Angus was born at Kingston, Ontario, on January 11th, 1842, and in 1865 he entered upon an apprenticeship with the Hon. Elijah Leonard, who was at that time engaged in the manufacture of sawing machines, threshing machines, water turbines and an occasional steam engine. Books and engineering periodicals were scarce but Mr. Angus was an earnest student and a remarkably ingenious mechanic, and with the aid of a few well-selected books and papers, was able in his early years to make the drawings for a number of steam engines, which were later installed.

When the town of St. Thomas decided in 1873 or 1874 to put in its first pumping engine Mr. Angus made the necessary designs and drawings and supervised the construction of the machine which proved very successful. This was followed in the next year, by a pumping engine for Sarnia, and since that time he has designed and superintended the construction of a very large number of engines and other machines.

For over thirty years he was with E. Leonard and Sons, London, and during a large part of this time he had charge of the shop. He also served as master mechanic with the Standard Oil Company, Cleveland, Ohio, for a few years, and during his later years Mr. Angus had a very busy life as a consultant on engineering matters.

Mr. Angus showed an enthusiastic interest in every engineering cause, and joined The Institute as a Member on April 18th, 1922. He was the first Canadian member of the American Society of Mechanical Engineers.

Professor R. W. Angus, M.E.I.C., head of the Department of Mechanical Engineering, University of Toronto, is one of Mr. Angus' two surviving sons.

R. O. Wynne-Roberts, M.E.I.C.

Robert Owen Wynne-Roberts, M.E.I.C.

Members of The Institute will learn with regret of the death of Robert Owen Wynne-Roberts, M.E.I.C., at Toronto on February 5th, 1935.

Mr. Wynne-Roberts was born at Liverpool, England, on October 12th, 1864, and in 1882-1889 was assistant town engineer of Llandudno, Wales. In 1889-1894 he was borough, water and gas engineer for Caernarvon, and was subsequently, until 1898, borough and water engineer of Oswestry. From 1898 until 1907 Mr. Wynne-Roberts was in South Africa, acting as city and water engineer of Capetown. Coming to Canada in 1910 he entered private practice. and was later retained by the city of Regina and the Saskatchewan government before he settled in Toronto and established the firm of Wynne-Roberts, Son and McLean, consulting engineers. Mr. Wynne-Roberts' practice was chiefly concerned with municipal undertakings, and at various times he was engaged by Belleville, Blenheim, Kincardine, New Liskeard, Niagara Falls, and many other municipalities.

Mr. Wynne-Roberts was a member of the Institution of Civil Engineers (Great Britain) and the American Society of Engineers. He was a graduate of the Royal Sanitary Institute, England.

He joined The Institute as a Member on March 11th, 1913, and took a keen interest in its affairs, having served on Council in the years 1922, 1923 and 1924 and been chairman of the Toronto Branch in 1920.

Albert Henry Pattenden, M.E.I.C.

Deep regret is expressed in placing on record the death of Albert Henry Pattenden, M.E.I.C., which occurred at Montreal, on February 26th, 1935, as a result of burns received in October, 1934, during an explosion which occurred in an oil switch in the power house at the Central Division of the Montreal General Hospital. At the time of the accident Mr. Pattenden, who was building superintendent of the Central and Western Divisions of the Hospital, was supervising the restoration of service after a breakdown.

Mr. Pattenden was born in London, England, on December 23rd, 1889, and from 1903-1907 was apprentice with Everett Edgecumbe, electrical and mechanical engineers in London. Coming to Canada in 1907, Mr. Pattenden was with the Montreal Light Heat and Power Company until 1910, when he became connected with the Monarch Electric Company, Montreal, being engaged on the design, fabrication and installation of power house and sub-station equipment. From 1912 until 1916 he was in charge of the electric car department in the Angus shops of the Canadian Pacific Railway Company. In 1916-1918 Mr. Pattenden was in charge of electrical and mechanical development work with W. J. O'Leary and Company, Montreal, and following this was until 1922 electrical engineer of eastern plants with the Canadian Consolidated Rubber Company, being transferred to the central office as electrical engineer of eastern and western plants at that time. Mr. Pattenden was later industrial engineer in the New Business Department of the Montreal Light Heat and Power Cons., and in 1929 was with Gallard and Company, Montreal. In 1932 Mr. Pattenden accepted the appointment which he held up to the time of the fatal accident.

Mr. Pattenden joined The Institute as an Associate Member on September 18th, 1923, and became a Member on June 15th, 1928.

PERSONALS

J. B. Clark Keith, A.M.E.I.C., chief engineer of the Essex Border Utilities Commission, Windsor, Ontario, has been elected president of the Association of Professional Engineers of the Province of Ontario.

John Stephenson, A.M.E.I.C., has joined the staff of the Canadian Atlas Steel Limited, Welland, Ontario, as plant maintenance engineer. Mr. Stephenson was formerly with the General Engineering Company of Canada Limited, Toronto.

W. J. Lecky, S.E.I.C., is now a demonstrator and sales engineer on the staff of Holman Machines Limited, Noranda, Que. Mr. Lecky, who graduated from McGill University in 1932 with the degree of B.Eng., was for a time with Noranda Mines Limited, at Noranda, and has more recently been with Howey Gold Mines Limited, at Red Lake, Ontario.

C. Hastings Skelton, S.E.I.C., who was formerly with the Nichols Engineering and Research Corporation of Canada, Limited, Montreal, is now connected with the research department of the Consolidated Paper Corporation, Wayagamack Division, at Three Rivers, Que. Mr. Skelton graduated from McGill University in 1930 with the degree of B.Sc.

M. Stuart Nelson, A.M.E.I.C., has recently become connected with Farand and Delorme, Limited, Montreal, as contracting engineer. Following graduation from McGill University in 1915 with the degree of B.Sc., Mr. Nelson was for a short time surveyor with the International Nickel Company, and from January 1916 until May 1917 he was engaged as a chemist, and on industrial inspection, etc. From May until November 1917 he was works engineer with A. F. Byers and Company Limited, and later until June 1918, Mr. Nelson was plant chemist with Canadian Electro-Metals at Shawinigan Falls, Que. From June 1918 until March 1919 he was a lieutenant with the Canadian Engineers. In May 1919 Mr. Nelson again became connected with A. F. Byers and Company Limited, as building foreman and superintendent, and from June 1920 until May 1923 was in charge of purchasing and subcontracts with the same firm. In May 1923 he joined the staff of A. Faustin Limited as assistant manager and secretary-treasurer and remained with that firm until recently.

Member of Institute on Directorate of Bank of Canada

W. D. Black, M.E.I.C., vice-president and general manager of the Otis-Fensom Elevator Company Limited, Hamilton, Ontario, has been elected to the directorate of the Bank of Canada.

Graduating from the University of Toronto in 1910 with the degree of B.A.Sc., Mr. Black was subsequently resident engineer for Gustav Lindenthal on the Kentucky river high bridge. In 1911 he joined the staff of the Otis-Fensom Elevator Company Limited, as manager for the Maritime Provinces and Quebec, and held that position until 1918 when he was engineer in charge of munition production for the company. In 1918-1921 he was manager of construction, and in 1921-1925 works manager, being appointed general manager in 1926.

In 1934, as president of the Industrial Relations Committee of the Canadian Manufacturers' Association, Mr. Black was appointed employers' delegate to the International Labour Conference in Geneva.

J. A. McCrory, M.E.I.C., Receives Important Appointment

J. A. McCrory, M.E.I.C., has been appointed vice-president and chief engineer of the Shawinigan Engineering Company Limited.

Mr. McCrory graduated from Pennsylvania State College in 1907 with the degree of B.Sc. in mechanical engineering, and coming to Canada in 1910, located at Toronto, where he was engaged on the design and construction of the London Hydro sub-station and in general building work. In 1912 he moved to Montreal, and for four years was employed on design and supervision of reinforced concrete construction. Mr. McCrory joined the staff of the Shawinigan Water and Power Company in 1916 as a designer, and on the formation of the Shawinigan Engineering Company Limited, in 1918, was appointed office engineer. During the intervening period he has been actively engaged on the design and investigation of a large number of hydro-electric developments for the Shawinigan Water and Power Company and others.

Mr. McCrory has taken an active interest in the affairs of The Institute since he became an Associate

J. A. McCrory, M.E.I.C.

Member in 1921 and a full Member in 1926, having been chairman of the Montreal Branch in 1929 and having represented that Branch on the Council of The Institute continuously since 1930.

Mr. McCrory is a member of the Corporation of Professional Engineers of Quebec, the Canadian Engineering Standards Association, the Canadian Electrical Association, and the American Society for Testing Materials.

Richard E. Heartz, M.E.I.C., is now assistant chief engineer of the Shawinigan Engineering Company Limited.

Mr. Heartz graduated from McGill University in 1917 with the degree of B.Sc., and immediately after graduation was employed by the St. Maurice Construction Company at La Loutre, on the construction of the Gouin dam. Later in the same year he enlisted with the Royal Air Force, received his commission early in 1918, and was appointed flying instructor, being demobilized in 1919. In that year he joined the Fraser Brace Engineering Company, Ltd., and was employed on the construction of the Big Eddy dam on the Spanish river. Mr. Heartz became resident engineer at La Gabelle development on the St. Maurice river in 1922, having joined the staff of the Shawinigan Engineering Company Limited in 1920. He was resident engineer on the St. Narcisse development on the Batiscan river in 1924-1925, and in 1926 was transferred to Montreal for investigation and preliminary design of hydro-electric developments. In 1927 Mr. Heartz was appointed resident engineer of the Paugan Falls development on the Gatineau river, and since the completion of that undertaking has been connected with the design and construction of different hydro-electric projects.

R. E. Heartz, M.E.I.C.

E. Geoffrey Cullwick, Jr.E.I.C., formerly assistant professor in electrical engineering at the University of British Columbia, Vancouver, B.C., has resigned from that position to join the professional staff of the Military College of Science, Woolwich, England, as lecturer in electrical engineering. It will be recalled that Mr. Cullwick, who graduated from Cambridge University in 1925 with the degree of B.A. in engineering, received honourable mention for his paper on "Engineering Education" submitted for the Past-Presidents' Prize for the year 1930-1931 and also for one on "The Effect of the Development of the Electronic Valve upon Electrical Engineering and Industry" which he submitted for the year 1932-1933. Following graduation, Mr. Cullwick was for a time connected with the Canadian General Electric Company, Ltd., at Peterborough, Ontario.

Dr. F. D. Adams, Hon.M.E.I.C., Honoured

Dr. Frank D. Adams, Ph.D., D.Sc., F.G.S.A., F.R.S., Hon.M.E.I.C., emeritus vice-principal of McGill University and eminent geologist and palaeontologist, has been appointed a foreign member of the Swedish Academy of Science of Stockholm, the body whose duty it is to select each year the person to whom shall be awarded the Nobel prizes in chemistry and physics. This is in recognition of the important contributions which Dr. Adams has made to the science of geology. Dr. Adams has also been elected a foreign member of Academia Asiatica, of Teheran, Persia.

Gordon McLeod Pitts, A.M.E.I.C., Elected President of the Province of Quebec Association of Architects

Gordon McLeod Pitts, a member of the firm of Maxwell and Pitts, Architects, Montreal, has been elected President of the Province of Quebec Association of Architects.

A native of Fredericton, N.B., Mr. Pitts graduated from McGill University in 1908 with the degree of B.Sc., and in 1909 received the degree of M.Sc. In 1916 he received the degree of B.Arch.

In 1906 Mr. Pitts was an engineer on construction with the Canadian Pacific Railway and in 1908 was a senior draughtsman with the Transcontinental Railway at Ottawa, Ont. In 1909 he joined the staff of P. Lyall and Sons Construction Co. Ltd., as engineer and superintendent, and in 1912 was supervising engineer for the construction of the Montreal High School for the Protestant Board of School Commissioners. He was assistant to John A. Pearson, Architect for the Parliament Buildings at Ottawa. In 1919 he joined the firm of Edward and W. S. Maxwell, Architects of Montreal, forming the firm of Maxwell and Pitts in 1923, thereby maintaining one of the oldest architectural practices in Canada.

Dr. R. W. Boyle, M.E.I.C., director, Division of Physics and Engineering, National Research Council, Ottawa, was elected chairman of the Ottawa Branch of The Institute for the year 1935, at the Branch's annual meeting recently.

Dr. Boyle is a graduate of McGill University, having received the degree of B.Sc. in 1905, that of M.Sc. (for research in physics) in 1906, and Ph.D. in 1909, and being awarded the 1857 Exhibition Research Scholarship, he was at Manchester University, England, from 1909 until 1911.

Returning to Canada, Dr. Boyle was assistant professor of physics at McGill University in 1912, and in the same year was appointed professor of physics at the University of Alberta. During the years 1916-1919, Dr. Boyle was in charge of experimental work on, and later consultant on new methods of submarine detection for the Admiralty Board of Inventions and Research. In the autumn of 1919 he resumed the professorship of physics and of electrical engineering at the University of Alberta, and in 1921 was appointed Dean of the Faculty of Applied Science at the same university, holding that office until 1929 when he accepted the appointment which he now holds.

H. G. Thompson, A.M.E.I.C., has been appointed manager of the Toronto sales office of Canadian Vickers Limited. Mr. Thompson completed his course at the University of Toronto following his return from overseas, where he served with the R.N.A.S., graduating in 1922 with the degree of B.A.Sc., and was subsequently engaged on engineering design, estimating and sale of heating and ventilating equipment with the Canadian Sirocco Company Limited, Montreal. From June to November 1923 he was supply engineer for pulp mill equipment with the Riordon Company Limited at Temiskaming, Que., and from that time until 1925 was connected with the Combustion Engineering Corporation Limited, as engineer on erection, service and sale of boilers, mechanical stokers, etc., and later as assistant to the Montreal manager. In October 1925 Mr. Thompson joined the staff of Affiliated Engineering Companies Limited, and in 1930 became associated with F. S. B. Heward and Company Limited, Montreal. At the inception of the E-I-C Engineering Catalogue in 1932, Mr. Thompson was appointed editor of indices. In 1934 he joined the sales force of Canadian Vickers Limited, specializing in the boiler field.

The Sir John Kennedy Medal Awarded to Robert Alexander Ross, M.E.I.C.

Robert Alexander Ross, M.E.I.C., receives the Sir John Kennedy Medal of The Engineering Institute of Canada for the year 1934.

This gold medal was established in commemoration of the great services rendered to the development of Canada, to engineering science and to the profession by the late Sir John Kennedy, past-president of The Institute. It is the highest honour which The Institute can bestow and is given only when the occasion warrants, as a recognition of outstanding merit in the profession or of noteworthy contribution to the science of engineering, or to the benefit of The Institute. Previous recipients of this award have been the late Colonel R. W. Leonard, M.E.I.C., G. H. Duggan, M.E.I.C., and A. J. Grant, M.E.I.C.

Born at Woodstock, Ontario, on August 29th, 1865, Mr. Ross was educated at the University of Toronto, graduating from the School of Practical Science in 1890.

Following graduation he was engineer in charge of the engineering department of the Canadian General Electric Company at Sherbrooke, Que., and Peterborough, Ont., until 1893, when he was appointed chief electrical and mechanical engineer of the Royal Electric Company of Montreal in charge of all engineering in station and shops. In 1896 Mr. Ross was granted the professional degree of E.E. by the University of Toronto, and since that date has been engaged in consulting engineering practice in Montreal, having been responsible for the design of many important electrical and power installations, including the West Kootenay Power and Light plant at Bonnington Falls, B.C., the Huronian Company's plant, and that of the Canadian Copper Company at Copper Cliff, Ont., the West India Electric Company, Jamaica, and many others.

R. A. ROSS, M.E.I.C.

Mr. Ross has acted at various times as consultant to most of the larger cities and municipalities throughout the Dominion and has carried out work in China, India, Straits Settlements, Russia, Finland, Scotland, Australia and the United States.

An interesting feature of Mr. Ross's professional career has been his long connection with the City of Westmount as their consulting engineer. His original commission from the city led to the installation of their well known municipal power plant and refuse destructor. This plant was built in 1905 and its success was largely due to the progressive ideas of the consulting engineer, while its operation as a municipal undertaking did much to bring about successive reductions in electrical rates in the Island of Montreal.

In 1916 at the time of its establishment, he was appointed a member of the Honorary Advisory Council for Scientific and Industrial Research, and later held the office of chairman of that body for some years. He was also chairman of the Lignite Utilization Board (1918-1924).

From 1918 until 1921 Mr. Ross served as a member of the Administrative Commission of Montreal, a body formed by the provincial government to save the city from financial chaos, and in 1921 he received the honorary degree of Doctor of Science from the University of Toronto.

In 1923 Dr. Ross was appointed a member of the Gregory Commission, a Royal Commission instituted by the provincial government of Ontario to investigate and report upon the affairs of the Hydro-Electric Power Commission of Ontario, and in 1932 was a member of the Board of Engineers which carried out an important investigation into power rates in the city of Quebec and reported to the city council thereon.

Dr. Ross has always taken a leading part in the affairs of The Engineering Institute of Canada, having joined the Canadian Society of Civil Engineers as a Member on May 6th, 1897. He served as a member of Council for eight years, was a vice-president from 1914 to 1916, and filled the presidential chair of The Institute in 1920.

He is a Fellow of the American Institute of Electrical Engineers.

Throughout Dr. Ross's career he has been unsparing in devoting time and effort to the service of his fellow engineers and the public. A man of unswerving integrity and clear vision, his independence of character and his professional competence have combined to give special value to his advice, a feature most clearly exemplified during his connection with the management of the affairs of the city of Montreal.

Always generous in his appraisal of others, he has never sought publicity as regards his own achievements, although these have marked him out, both as a distinguished public servant and an outstanding member of his profession.

Award of Medals and Prizes

Gzowski Medal

W. H. Powell, M.E.I.C., has been awarded the Gzowski Medal for the year 1933-1934 for his paper entitled "First Narrows Pressure Tunnel, Vancouver, B.C." which was published in The Engineering Journal for June 1934.

W. H. Powell, M.E.I.C.
Gzowski Medallist

F. E. Lathe
Plummer Medallist

D. E. Keeley
Leonard Medallist

F. A. Masse, Jr.E.I.C.
John Galbraith Prizeman

Mr. Powell graduated from McGill University in 1909 with the degree of B.Sc., and was subsequently first assistant and articled pupil to B. J. Saunders, D.L.S. At the beginning of the year 1910 he was with the Maritime Bridge Company, New Glasgow, as a draughtsman, and in 1910-1911 was assistant on a Dominion Hydrographical Survey in the neighbourhood of Prince Rupert. In the following year Mr. Powell was in charge of a subdivision survey in northern Saskatchewan with the Topographical Surveys Branch, Department of the Interior, and from March to August 1912 was in private practice on miscellaneous surveys. In August 1912 he was appointed city surveyor for the city of Vancouver which position he held for a number of years. In 1928 Mr. Powell became engineer for the Greater Vancouver Water District, and still holds that appointment.

Plummer Medal

The Plummer Medal Committee has awarded that medal for the year ending June, 1934, to Mr. F. E. Lathe, Director, Division of Research Information, National Research Council, Ottawa, for his paper on "The Utilization of Magnesian Carbonates" which appeared in the December, 1933, issue of The Journal.

Mr. Lathe is a graduate of McGill University, having received the degree of B.A. in chemistry in 1904, that of B.Sc. in metallurgy in 1907, and his M.Sc. in metallurgy in 1915.

From 1910 until 1924 Mr. Lathe was chief chemist or metallurgist with copper and nickel companies in British Columbia, Chile, Ontario and Quebec, with the exception of 1914-1915, when he was lecturer in metallurgy at the University of Toronto. From 1925 until the present time he has been with the National Research Council, first as technical assistant to the president, and for the last five years in the position which he now occupies. Mr. Lathe is a Fellow of the Canadian Institute of Chemistry and the American Association for the Advancement of Science, a member of the Canadian Institute of Mining and Metallurgy, the American Institute of Mining and Metallurgical Engineers, and the Canadian Ceramic Society.

Leonard Medal

Mr. D. E. Keeley is the recipient of the Leonard Medal for the year 1933-1934, the award being for his paper on "Guniting at the McIntyre Mine" which appeared in the June, 1934, Bulletin of the Canadian Institute of Mining and Metallurgy.

C. B. Charlewood, S.E.I.C.
Phelps Johnson Prizeman

Mr. Keeley, who is a graduate of Queen's University, Kingston, is mine superintendent of McIntyre Porcupine Mines Limited, Schumacher, Ontario. He is a member of the Canadian Institute of Mining and Metallurgy. Leonard medallists must be members either of The Engineering Institute of Canada or of the Canadian Institute of Mining and Metallurgy.

Students' and Juniors' Prizes

Two of these prizes were awarded this year as follows:

The John Galbraith Prize (province of Ontario) to F. A. Masse, Jr.E.I.C., assistant chemist, Abitibi Power and Paper Company, Sault Ste. Marie, Ontario, for his paper on the "History of Paper Making."

The Phelps Johnson Prize (Province of Quebec, English) to C. B. Charlewood, S.E.I.C., who is attached to the mechanical department of Noranda Mines Limited, Noranda, Que., for his paper entitled "Steam Distribution in the Newsprint Mill."

ELECTIONS AND TRANSFERS

At the meeting of Council held on February 22nd, 1935, the following elections and transfers were effected:—

Members

CAMPBELL, Lorne Argyle, vice-president and general manager, West Kootenay Power and Light Company, Limited, Trail, B.C.

IRWIN, Gifford Melville, B.Sc., (McGill Univ.), city engr. and water commissioner, City of Victoria, B.C.

Associate Member

RIMMER, Ralph Horton, B.S. (Chem.), (Univ. of N.C.), asst. supt., aluminum plant (Arvida works), Aluminum Company of Canada Ltd., Arvida, Que.

Transferred from the class of Associate Member to that of Member

BONN, William Ernest, (Glasgow & West of Scot. Tech. Sch.), engr. in charge, Toronto district, Canadian Dredging Co. Ltd., Toronto, Ont.

CREALOCK, Archie Burgess, B.A.Sc., (Univ. of Toronto), consltg. engr., Kent Bldg., Toronto, Ont.

SMYTHE, Ro. Eric, Colonel, D.S.O., M.C., B.A.Sc., (Univ. of Toronto), director, Technical Service Council, Toronto, Ont.

WILSON, William Stewart, B.A.Sc., (Univ. of Toronto), secretary, Faculty of Applied Science and Engineering, University of Toronto, Toronto, Ont.

WOOD, James Robert, Associate (Civil Engrg.), (Royal Technical College), asst. city engr., Calgary, Alta.

Transferred from the class of Junior to that of Associate Member

COCKBURN, John Macmillan, B.Sc., (Queen's Univ.), engr., telephone systems engrg. dept., Northern Electric Co. Ltd., Montreal, Que.

HICKS, Ben Church, B.Sc., (McGill Univ.), elect'l. engr., Shawinigan Water & Power Company, Montreal, Que.

JUSTICE, Claude Wellington, B.Sc., (Univ. of Man.), asst. to plant engr., Noranda Mines Ltd., Noranda, Que.

LANGLOIS, William Lawrence, B.A.Sc., (Univ. of Toronto), acting asst. district engr., Dept. of Northern Development, Wanapitei, Ont.

MITCHELL, J. Murray, B.Sc., (McGill Univ.), district traffic supt., Bell Telephone Company of Canada, Three Rivers, Que.

Transferred from the class of Student to that of Associate Member

HANGO, J. Raymond, B.Sc., (Univ. of Alta.), asst. elect'l. engr., Duke-Price Power Co. Ltd., Arvida, Que.

JUBIEN, Ernest Burchell, B.Sc., (McGill Univ.), engrg. dept., Canadian Industries Limited, Montreal, Que.

LALONDE, Jean Paul, B.A.Sc., C.E., (Ecole Polytech., Montreal), chief engr., J. M. Eugene Guay Inc., consltg. engr., Montreal, Que.

MILLER, Charles, B.Sc., (Queen's Univ.), engrg. staff, Duke-Price Power Co. Ltd., Arvida, Que.

Transferred from the class of Student to that of Junior

DUTTON, William Lawrason, B.A.Sc., (Univ. of Toronto), engr., Union Gas Company of Canada Ltd., Chatham, Ont.

FISHER, Sidney Thomson, B.A.Sc., (Univ. of Toronto), design engr., Northern Electric Co. Ltd., Montreal, Que.

PIDOUX, John Leslie, B.Sc., (Univ. of Alta.), instr'man., Dept. Public Works of Alberta, Calgary, Alta.

Students Admitted

CROTHERS, Donald Coverdale, (Queen's Univ.), 11 Sydenham St., Kingston, Ont.

DAVIDSON, Arthur Campbell, (Univ. of Man.), 1732-11th St. West, Calgary, Alta.

At the meeting of Council held on February 7th, 1935, the following Students were admitted:—

BAGGS, William Clyde, (McGill Univ.), 3506 University St., Montreal, Que.

BONNELL, A. Robertson, (Univ. of N.B.), 447 Charlotte St., Fredericton, N.B.

BREWER, Douglas Jared, (Univ. of N.B.), 269 Woodstock Road, Fredericton, N.B.

DUNLOP, James Russell, (McGill Univ.), 184 Primrose Ave., Ottawa, Ont.

MAYHEW, Earle Chandler, Lieut., O.M.E., (Grad. R.M.C.), (Queen's Univ.), Headquarters, M.D. No. 3, Kingston, Ont.

MORRIS, Harold Kempffer, (McGill Univ.), 2063 Stanley St., Montreal, Que.

ZION, Alfred Bernard, (McGill Univ.), 5280 Byron St., Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Junior Institute of Engineers:
Transactions, 1934.

American Society for Testing Materials:
Proceedings of 37th Annual Meeting, volume 34, parts 1 and 2.

American Institute of Electrical Engineers:
Transactions Volume 53, 1934.

Reports, etc.

Society for the Promotion of Engineering Education:
Report of Investigation 1923-1929 and a Report on Technical Institutes, 1928-1929.

Institution of Structural Engineers:
Report on the Treatment of Welded Structures by the Metallic Arc Process.

Canada, Department of Labour: Report for the year ending March, 1934.

Quebec Bureau of Mines: Annual Report for 1933. Part B.

Shawinigan Water and Power Company: Annual Report, 1934.

Hamilton, Ontario: Annual Reports of the City Engineer for the years 1931-1932 and 1933.

Virginia Polytechnic Institute: Catalogue, 1934.

Institution of Civil Engineers: List of Members, 1935.

Technical Books, etc., Received

American Iron and Steel Institute: Directory of the Iron and Steel Works of the United States and Canada. 21st edition. 1930.

Diesel Engine Design, by H. F. Shepherd. (*John Wiley and Sons.*)

The Trisection of any Rectilineal Angle, by Geo. Goodwin. (*Presented by F. Condon, M.E.I.C.* This book was among the effects of the late M. J. Murphy, A.M.E.I.C., and is inscribed as having been presented to the late Dr. Martin Murphy by the author.)

An Introduction to Structural Theory and Design, by Sutherland and Bowman. (*John Wiley and Sons.*)

The Principles of Motor Fuel Preparation and Application, by Nash and Howes. (*John Wiley and Sons.*)

Hydrothermal Synthesis of Calcium Hydrosilicates, by V. A. Vigfusson, G. N. Bates and T. Thorvaldson.

Studies on the Thermochemistry of the Compounds Occurring in the System CaO-Al_2O_3-SiO_2. V. The Heats of Formation of Tricalcium Silicate and Dicalcium Silicate, by O. K. Johannson and T. Thorvaldson.

BOOK REVIEWS

Report on the Treatment of Welded Structures by the Metallic Arc Process

Published by the Institution of Structural Engineers, London, England, 1934. 5½ by 8½ inches, photos, diagrams, etc. 5 shillings. Paper.

Reviewed by P. L. Pratley, M.E.I.C.*

This report is definitely a notable contribution to the proper appreciation of this comparatively new art—the application of electric welding processes to structural steel fabrication.

Part I, which deals with the process and its technique, is particularly valuable, constituting as it does a clear presentation of the aim, the materials, the methods, the difficulties encountered and the experience gained up to date both in practice and research.

The basic principles are explained with commendable lucidity and there can be no doubt but that a large number of engineers interested in arc welding as a means of accomplishing the connection and physical integration of metal parts will find here just that amount of technical description which will enable them to understand the present state of the art and its rapid development both in respect of direction and concerning the various limiting influences.

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*Monsarrat and Pratley, Montreal.

The references to flux-coated electrodes, to the functions of their chemical components, to the gases evolved, and to the current absorbed, are concisely expressed and very well illustrated.

The variety of deposited beads, their critical analysis, and some valuable practical hints and suggestions regarding the length of run available or desirable from standard lengths of electrodes of specific gauges, are all treated in this first part and accompanied by useful though simple illustrative diagrams.

Procedure in fabrication may differ as between various shops and individual supervisors, but such informative notes on accepted practice under stated conditions are eagerly sought by those engaged in developing the process, under similar, or even dissimilar conditions. The experiments on distortion which are described in the Report, on pages 35 to 39, are both interesting and instructive and serve to remind the interested reader that experience and study are both necessary and sufficient to avoid trouble in this connection.

The second section of the Report, Part II, deals with the metallurgical aspect and treats of the various electrodes, the preparation of the surfaces, the resulting fusions, and the types of corrosion, slag inclusion, and other sources of defect. Numerous micro-photographs illustrating good and bad beads, the effects of various treatments upon the electrodes, actual joints between weld metal and parent metal, etc., etc., including a series of X-ray exposures and a number of diagrammatic sketches add many valuable and informative pages to this portion of the Report.

The following section, Part III, deals with sundry tests made under shop conditions and is again copiously illustrated with photographs, sketches and diagrams.

Part IV is a very useful section in the nature of suggestions for specifications covering ordinary practice and including recommended working stresses and types of connection.

A glossary of technical terms and a very complete index round out the volume.

Naturally, the references to experiment and practice concern "old country" shops, and one or two features such as the use of a two-number indicator to describe the weld instead of the throat thickness are new to the present reviewer. There may be advantages in this nomenclature and no doubt those actually concerned in production, such as designers, supervisors, and operators, will reach their own opinions as to the desirable means of specifying the sizes of the actual fillets. In the method used, the indication 8/10 means that a No. 8 electrode of the standard 18-inch length would deposit 10 inches of run which is equivalent to a 7/32-inch fillet using the throat dimension as is present common practice in Canada. Earlier in the Report mention is made of the fact that there exists an optimum length of run for each gauge of electrode which produces the best general economy with the greatest ease of operation. The comfort of the operator is stressed as an essential feature in the securing of high class welding and the supply of proper equipment, power plant, electrode holders, eye-shields, etc., is referred to as only reasonable if good workmanship is to be obtained.

The perusal and study of this Report is cordially recommended to all engineers and operators closely concerned with the process or with the acceptance of welding and the Institution of Structural Engineers of Great Britain are certainly to be congratulated on this production.

Les Réseaux de Transmission d'Energie

By Jean Fallou, Librairie-Imprimerie Gauthier-Villars, Paris, 1935. 6½ by 10 inches, 558 pages, 125 frs. Paper.

Reviewed by Dr. A. Frigon, M.E.I.C.*

This is a complete and elaborate theoretical treatment of the most important practical problems encountered by the electrical engineer specializing in the design and operation of power transmission systems. The author, a doctor of science and a graduate engineer of "L'Ecole Supérieure d'Electricité," is now attached as consulting engineer to "L'Union d'Electricité." He is familiar with recent developments in this field and has given due consideration to the practice followed on this side of the Atlantic.

The book has been divided into four sections, each containing all the important essential principles necessary for the understanding of the particular problems involved. The first part, in which we find the general theory of transmission systems, serves as an introduction to the methodical discussion of the various systems of transmission now in use. Their regulation and stability are also considered here.

The second section has been devoted to the study of overloads. After having developed a method for the calculation of short circuit currents, the author reviews the troubles caused by overloads; abnormal heating, surges and excess-voltage induced in telephone communication lines. Special attention is given to the means available for limiting overloads. The different methods of grounding the neutral point are also analysed. The last chapter in this section discusses modern automatic instruments used for limiting and recording short circuits.

*Dean, Ecole Polytechnique, Montreal.

The third part contains the general theory of transient and normal conditions which produce excess-voltage. The author lays down a number of formulae frequently used for the calculation of transient phenomena and indicates the characteristic magnitudes which must be assigned to the different parts of a transmission system in order that they may be assimilated to simple circuits. Several causes of over voltage, such as resonances, ground surges, switch manipulation, etc. are analysed. A special chapter describes the registering of excess-voltage by the klydonograph.

The fourth part treats of protective systems from a theoretical viewpoint. A description of numerous up-to-date devices is also included.

As a whole this is an excellent reference book, well printed and profusely illustrated with diagrams. The reviewer finds it difficult to understand why the author has not considered it advisable to provide such an important work with an index.

BULLETINS

Vitrified Clay Products.—Three booklets have been received from the National Sewer Pipe Company Limited, Toronto, as follows: One 8-page booklet containing particulars on wall coping; another, 16-page booklet dealing with clay pipe, outlining the effect of chemicals on this product, its uses, and methods of laying; and a third containing 16 pages on flue lining, with reasons why flue lining should be used, with typical applications, standard sizes manufactured, and a modern chimney construction by-law.

Underfeed Stoker.—A 16-page booklet received from the Combustion Engineering Company Inc., New York, deals with the new Type-E centre-retort underfeed stoker. Particulars of the drive, automatic control, forced draught equipment, and details of construction are given as well as sample applications to various types of boilers.

Metal Spray Gun.—A 12-page bulletin issued by the Metal Spray Company, Los Angeles, Calif., gives particulars regarding specifications, and application of metal spraying.

Piston Pumps.—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued a 4-page leaflet giving details of their horizontal, piston pattern pumps, simplex and duplex for petroleum oil refineries. These are made in a number of sizes, capable of handling liquids up to a temperature of 700 degrees F.

Aluminum Foil.—A 4-page folder received from the Alfol Insulation Company Inc., New York, outlines the use and advantages of aluminum foil as a modern fire-proof insulation.

Accumulators.—A 4-page pamphlet received from the Seamless Steel Equipment Corporation, New York, describes the advantages and methods of operation of Hydraulik compressed air accumulators without pistons or floats, also hydraulic presses. This company has recently taken over the representation of the Hydraulik, G.m.b.H. of Duisburg, Germany.

Compressors.—A 4-page leaflet received from the Canadian Ingersoll Rand Company Limited, Montreal, gives particulars of the XVH compressor which is available in capacities ranging from 400 c.f.m. upward.

The Municipal Diesel Plant of the City of St. Hyacinthe

From information supplied by

Nicholas Sauer,

Diesel plant, City Hall, St. Hyacinthe, Que.

In the spring of 1933 the question of building a municipal power plant for the city of St. Hyacinthe came under consideration, as the result of an endeavour to secure lower power rates for the citizens.

Under the direction of the city council, a detailed study of the subject was made, it was decided to install Diesel engines, many Diesel plants on the North American continent and in England and Germany were inspected, and an estimate of the cost of an undertaking of this nature was prepared.

The city council recommended that a bond issue for $310,000 be arranged for the establishment of a Diesel electric plant and a distribution system for the city, and requested tenders on the equipment required in accordance with the city's specifications.

In the beginning of 1934 a contract was awarded to the Montreal Locomotive Works Limited for four 600-h.p. Diesel engines, to be designed by McIntosh and Seymour Inc. of Auburn, N.Y., the contracts for the electrical equipment were placed with the Canadian General Electric Company and the Canadian Westinghouse Company.

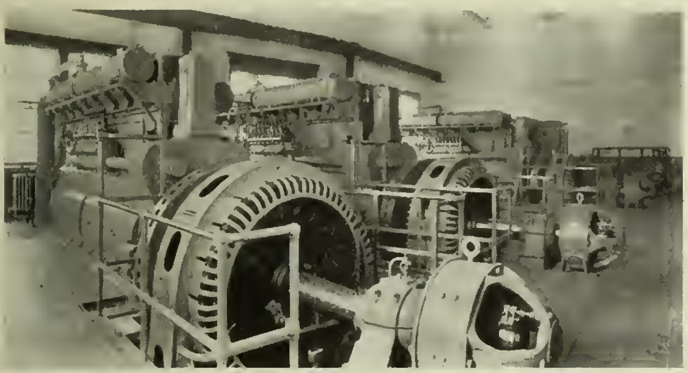
Work on this plant was commenced in April 1934, and operation started on November 30th of the same year, power being supplied for the waterworks and the city street lighting system.

The new plant has been installed in space already available in the city waterworks building, thereby saving the cost of a building and greatly reducing the cost of the equipment necessary for supplying cooling water. On the other hand there is a certain disadvantage in that the plant is not centrally located with respect to the load, and the limited space in the engine room imposed some restriction regarding the arrangement of the engines and auxiliaries.

This engine room is 59 feet long by 34 feet wide, 20 feet high and contains four 600-b.h.p. Diesel electric units and auxiliaries, with provision for one additional unit.

The basement contains the engine sump-tanks, oil-coolers, air receivers, water pumps and fuel oil transfer pumps.

A good deal of consideration was given to the construction of the engine foundations. The sub-soil is clay, and in order to isolate the running machinery it was decided to place a 2-inch layer of cork below each foundation block in the sub-foundation, the foundation blocks being arranged in pairs, each pair standing on a separate concrete mat.



Diesel Electric Units, St. Hyacinthe.

Each engine is rated at 600 b.h.p. at 360 r.p.m. The eight cylinders are 12½-inch bore and 18-inch stroke. The engines are of the 4-cycle, solid injection, vertical, totally enclosed type, direct connected to a.c. generators and exciters. The floor space for each engine is 16 feet 7½ inches by 8 feet 1½ inches, the height is 8 feet 1 inch.

The engines are equipped with Bosch fuel pumps and nozzles, and are regulated by means of a Woodward isochronous governor.

For starting, two 15 c.f.m. 350 pounds pressure air compressors, one driven by a 7½ h.p. motor and one by a 20 h.p. gasoline-engine are provided. The air is stored at 350 pounds pressure in four air receivers. The 20-h.p. gasoline generator compressor set was installed as a safety measure, the generator to act as a spare exciter and otherwise to be connected to an auxiliary power house lighting circuit.

Each engine has its individual oil circulating system, which is forced feed throughout. The oil is stored in a 300-gallon overhead tank.

The cooling water for the engines is obtained from the city mains which deliver to a 5,000-gallon overhead tank. The engines are supplied by gravity from the tank, and the water is then discharged to an underground basin of the city's filtration plant.

To prevent excessively cold water from entering the engine jackets, a motor-driven centrifugal water pump with a capacity of 150 gallons a minute was installed between the main inlet header and the water outlet of the engines to recirculate part of the warm water discharge. A duplicate pump serves as a standby. The recirculating system is automatically controlled by a thermostat and is equipped with an alarm to guard against failure of the water supply.

Suction air is taken from outside through filters, and the exhaust gases pass from the cylinders into a water-cooled manifold, and are then led to a silencer located outside the building in an underground concrete pit. Each engine is equipped with an individual air-filter and silencer.

Fuel oil is delivered to the plant by tank cars and stored outside in a 30,000-gallon steel tank. The fuel oil used at the plant has the following characteristics:

Specific gravity at 70 degrees F.	0.86 to 0.90
Flashpoint p.m.	180 to 200
Viscosity (Saybolt Universal) at 100 degrees F.	35 to 40
B.t.u.'s per pound (gross)	19,500 min.

No provision was made for the recovery of the heat in the cooling water and the exhaust gases, due to the fact that the plant was designed to be operated eventually as a standby for a hydro-electric plant.

The Diesel engines are directly connected to four 500-kv.a., 4,000-volt, 3-phase, 60-cycle, 360 r.p.m. generators.

The direct-connected exciters are 9.5 kw., 125-volt, shunt wound machines and the switch gear necessary for the control of the alternators, feeders and auxiliary circuits is located in a central part of the building adjacent to the engine room.

Before delivery, tests were run on the Diesel generator sets in the shops of the Montreal Locomotive Works, and each engine was observed for twenty-four hours at full load, two hours at 10 per cent overload, and one hour each both at ¾ load and ½ load. The performance of the engines was equally steady at all loads. The fuel consumption was as follows:

B.h.p. developed	Pounds of Fuel per b.h.p. per hour	Thermal Efficiency (b.h.p. basis) gross per cent
660 at 10 per cent overload	0.382	34.3
600 at 1/1 load	0.377	34.8
450 at ¾ load	0.375	35.0
300 at ½ load	0.406	32.2

The fuel used had an average calorific value of 19,430 B.t.u. (gross) per pound.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

The November meeting of the Branch was treated to a lecture on "Gasoline" by Mr. J. M. Miller, B.Sc., a graduate of the University of Michigan, and at present lubricating engineer with the Standard Oil Company of Indiana.

Gasoline

Mr. Miller explained that there were two fundamental principles in the production of gasoline. First, the separation of various products contained in crude oil, and second, the purification of these products. Then step by step each phase of the work was explained and discussed.

He then read a brief technical discussion of gasoline, explaining that the automobile, the chief user of gasoline, is a chemical factory on wheels. Its principal function is the manufacture of energy; enough of which is stored in one gallon of gasoline to drive a light car 450 miles, if efficiently used. The creation of energy is brought about by the union of the oxygen of the air and gasoline. The table below gives the figures of this generation of energy in an average engine:

Going In		*Coming Out*			
Gasoline	6.25 pounds	CO_2	10 pounds	87.00 cubic feet
		H_2O	6.9 "	0.83 "
Air	1,200 cubic feet	CO	5.9 "	80.00 "
		H_2	0.2 "	40.00 "
		O_2	0.2 "	2.00 "
		N_2		775.00 "

Due to incomplete combustion, there is a slight shrinkage in the number of volumes coming out. Also, that 6.25 pounds of gasoline makes 6.9 pounds of water in an average engine or 8.95 pounds of water with perfect combustion.

The item of greatest importance is volatility. This factor governs —(1) ease of starting, (2) uniformity of operation (vapour lock), (3) ease of acceleration, (4) uniform manifold distribution and crank-case dilution.

Acceleration is a difficult property of the fuel to ascertain. It is dependent on engine design, manifold design, temperature and carbureter mixture. Any fuel would give as good results as another if the above factors were adjusted or allowed for when using a particular fuel.

The problem of the gas man is to improve on the four main points mentioned above. The automotive designer must improve his fuel systems.

A few statistics in connection with the petroleum industry, show that it is the second largest in the United States (agriculture being the largest). It has $26,000,000,000 capital, employs over 3,000,000 people, operates over 150,000 miles of main line railroad and over 100,000 miles of pipe line, the longest being 1,500 miles. In the Detroit area there is a gasoline station for every 125 cars.

A Steel Mill in Russia

Our December meeting was entertained by Mr. M. J. Wohlgemuth, who is general engineer with the Westinghouse Electric and Manufacturing Company. The speaker spent nearly three years (1930-33) in Russia in conjunction with the installation of steel mill equipment in what is the largest steel mill in Russia. This mill was located at a site where in 1929 there were no people living within a 25-mile radius and in 1932 there were over 150,000 people at the site. The mill is located on one bank of a river. It is 3½ miles long and ¾ of a mile wide. The plant was originally designed for the production of 1,000,000 tons per year which was altered to 1,250,000 tons per year. At present, the plant is producing 500,000 tons per year, 300,000 tons being in structural shapes and the balance in rails and merchant quality. The plant has four large coking ovens and fifteen one-hundred-and-fifty-ton open hearth furnaces. Several reels of moving pictures showing the views of the plant and scenes taken by the speaker were enjoyed.

At the conclusion of the pictures, Mr. Wohlgemuth was bombarded with questions on conditions in Russia.

All food was rationed, although there were special quotas for the specialists. Russian workers are ordered from one job to another the same as a soldier in the army. In this instance, Russian labourers were ordered to the site of the new plant. No provisions had been made for housing them nor had any of the usual sanitary provisions been installed, although the Russian government had provided special accommodations for the imported help. The Russian workers overcame their difficulties by digging into the surrounding hills and erecting long rows of dugouts. The speaker found that the Russian workers were very incompetent but quite anxious to learn. Practical universities have been established in all such undertakings to help educate the workers. The rate of pay varies from $25 per month minimum to $400 per month maximum. However, this difference is partially offset by the fact that different classes must trade at certain class stores and the prices of goods vary accordingly. There is a good deal of propaganda against religion, the common slogan being "Religion is Opium for the Soul." However, the speaker added that there were still groups of young people to be seen in the churches.

Calgary Branch

J. Dow, M.E.I.C., Secretary-Treasurer.
H. W. Tooker, A.M.E.I.C., Branch News Editor.

On Monday, January 14th, 1935, over fifty members of the Calgary Branch and their friends heard Wm. Storrie, M.E.I.C., of Gore, Nasmith and Storrie, consulting engineers, Toronto, give a most interesting illustrated address on "Engineers and Public Health."

Engineers and Public Health

In his opening remarks, Mr. Storrie expressed his delight in being in Calgary again and meeting old friends, he also expressed satisfaction in his visit to the Glenmore dam.

The speaker declared that under no consideration in matters of the public health should a city or consulting engineer allow a city council to "run him" in regard to technical matters. A council has every right to interfere in matters of policy, but it was the duty of the engineer to guide the council. The real live public health engineer affords protection to the public, and it is his privilege to design, construct and control all schemes designed to bring about conditions which have the welfare of everyone at heart.

Public health engineering might be defined as the art of directing the forces of nature in the direction of public health in which there are large fields.

Purification of water has now become a well defined art from which there is not a great deal to learn, but there is a great deal of knowledge to be gained regarding sewage disposal which is now in, more or less, the experimental stage.

Stating that typhoid fever is the index of the nature of the water supply, chlorination of water has reduced the death rate by this disease almost 90 per cent. Mr. Storrie then cited several projects which have caused a great deal of experimenting and study. Toronto was a case in point, where 10 per cent more chlorine is used than in ordinary plants; the water was then de-chlorided before use. Comparisons were also made between Ottawa and Hull plants. In 1914 when Ottawa first used chlorine in the water supply there were only twenty-eight cases of typhoid fever, as against Hull with two hundred cases which did not use chlorine, though the two cities obtain their water supply from practically the same point in the Ottawa river, and Ottawa has five times the population of Hull.

Sewage treatment is difficult, the speaker said, on account of the continual variation of the sewage to be treated.

Mr. Storrie suggested a good slogan for the water-works engineer; it is "To know your sewage before designing a plant."

The address was illustrated by interesting slides, showing water supply plants of Toronto and Ottawa, and several large sewage disposal plants recently constructed.

Following this, a short discussion took place, after which a vote of thanks was given the speaker by H. J. McLean, A.M.E.I.C.

At the meeting of the Calgary Branch of The Institute held on January 24th, 1935, two thirty-minute addresses, with organized discussion, were presented.

The first, by H. B. Sherman, A.M.E.I.C., was on "Power Distribution in Alberta" and was illustrated by a number of interesting lantern slides, and the second by J. H. Ross, A.M.E.I.C., was on "The Fundamentals of Engineering Education and Vocational Training."

Power Distribution in Alberta

Mr. Sherman described the ideal power distribution system as one sufficiently comprehensive to make electricity available to every resident at rates which would permit the full use of the service being made. However, owing to the sparseness of the population in some sections of Alberta it was not economically feasible to extend transmission lines to them.

Mr. Sherman then went on to describe the Calgary Power Company's system with main generating stations at Kananaskis, Horseshoe and Ghost, giving the main load centres, transmission voltages, step down transformer stations, and details of the distribution system generally. This included something on the design and construction of transmission lines and a few of the main causes of trouble.

The Fundamentals of Engineering Education and Vocational Training

Mr. Ross stated that the three phases of the engineer's education beyond the secondary or high school were (*a*) general education, (*b*) general engineering education and (*c*) vocational training. Under (*a*) was included all those studies which had no direct application to engineering, in (*b*) were included those studies taken by all students in applied science and engineering courses in universities, and (*c*) included all work or studies having a direct application to the particular branch of engineering to be followed.

The speaker then gave an outline of what was being done now and what in his opinion should be done to improve the present training and assist the engineer in placing himself in his proper status in a civilization based largely on science. He further outlined the qualities necessary in a young man if he was to be a successful engineer.

Mr. Ross concluded by stating that "whether a man was a civil, a mechanical, or a chemical engineer was not fundamentally important so long as his basic training was sound." In other words, an engineer should be trained as an engineer and specialization should be the same as in other professions, viz. by training and experience after graduation from university.

At the conclusion of the meeting a hearty vote of thanks was given both speakers by P. F. Peele, A.M.E.I.C.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
J. E. Hawkins, S.E.I.C., Branch News Editor.

The Lethbridge Branch of The Engineering Institute of Canada held its first meeting of 1935 at the Marquis hotel on January 12th, at 7.30 p.m., with C. S. Donaldson, A.M.E.I.C., in the chair, and about forty members present.

A short business meeting was held, during which the annual report was presented and passed.

A motion picture film dealing with the metallurgical plant at Trail, B.C., was then shown. The complete operation of the plant, from the preliminary crushing of the lead zinc ore, through to the final casting of the lead and zinc, and the recovery of the silver and gold from the residue, was shown.

Development of The Turner Valley Oil Fields

R. S. Winter then introduced the guest speaker of the evening, S. E. Slipper, chief geologist of the Canadian Western Natural Gas Co., who spoke on "The Development of The Turner Valley Oil Fields." He outlined the history of Turner Valley from the time of the Dingwell discovery in 1913 down to the present time, when it has become Canada's greatest gas and petroleum field.

Turner Valley, situated approximately forty-five miles southwest of Calgary in the foothills of the Rocky Mountains, is a longitudinal valley lying parallel with the Rockies, cut laterally by the north and south branches of Sheep Creek. It is classed as an eroded sandstone anticline; leaving the valley with sandstone ridges.

It was in 1924 that the main horizon was struck in the limestone by the Royalite No. 4. Of particular interest was the speaker's description of the geology of the valley, with the use of a log of a typical well.

Mr. Slipper pointed out that the oil in the limestone is unique in that it does not come directly from the wells as oil but comes out as gas which must be condensed. This is done by means of separators and absorption plants. The use of absorption plants has increased the production of naphtha per unit of gas considerably, especially with the lower pressures now prevailing.

The wells were not closed in completely from 1924 to 1932 and consequently the original rock pressure is not know, but it has been estimated from observations as about 2,000 pounds per square inch. The first closed pressure obtained was 1,835 pounds per square inch. The great waste of gas from 1929 until 1932 amounted to about 500 million cubic feet daily, having a heat value of 1,100 B.t.u. The field was closed in 1932, and restrictions placed on this waste. In this regard the speaker mentioned the work of the Conservation Board, illustrating his remarks with a number of contour maps. He pointed out that a drop in pressure has taken place in certain places in the valley from 2,000 pounds in 1924 to 900 pounds in 1934.

Mr. Slipper answered a number of questions; Messrs. Donaldson, J. B. deHart, M.E.I.C., and Thrall taking part in the discussion. C. S. Clendening, A.M.E.I.C., moved a vote of thanks to the speaker.

Mr. Slipper's talk was followed with a film on the development of Turner Valley, showing the work involved in bringing a well into production. The processes of refining and distribution of the gasoline concluded this interesting subject.

The programme was followed by a delightful buffet lunch.

Democracy at the Crossroads

On December 15th, 1934, the Branch held a dinner meeting at the Marquis hotel, Lethbridge, taking the form of a ladies night. The speaker, Mr. D. H. Elton, K.C., addressed the meeting upon the subject: "Democracy at the Crossroads." Mr. Elton was introduced by C. S. Donaldson, A.M.E.I.C. Some forty members and guests attended.

The speaker stated that all found themselves in a dilemma to-day; nearly everything was at a standstill, social, business, industrial and even educational activities.

One did not know whether the radical left or the reactionary right was the road to follow or whether both could be avoided.

He outlined many of the causes of this state of perplexity and the difficulties confronting governments of the day. In his opinion there was only one way of solving these difficulties, and that was through obedience to constituted law and authority by increased individual responsibility, the shaking off of indifferent attitudes and the assuming of those duties which the fulfilment of citizenship imposed.

Mr. Elton then observed that three things were essential to good government; things the individual should do, namely, to vote intelligently, to vote unselfishly, to vote honestly. He closed by saying that democracy would prosper in the degree in which it knows good citizenship.

Mr. F. A. Rudd thanked the speaker on behalf of the Branch for his very able address and following this, bridge was played for the remainder of the evening.

London Branch

S. G. Johre, A.M.E.I.C., Secretary-Treasurer.
J. R. Rostron, A.M.E.I.C., Branch News Editor.

The annual dinner meeting of the Branch was held on January 23rd, 1935, at the Highland Golf Club house, the retiring chairman of the Branch, Frank C. Ball, A.M.E.I.C., presiding.

The guest speaker of the evening was Professor P. H. Hensel, of the department of business administration of the University of Western Ontario.

Some Relations Between Technical and Business Training

Professor Hensel's address was regarding "Some Relations Between Technical and Business Training," in which he sketched the difference in outlook brought by training in the business world and in schools of technical engineering.

Much of the progress of business was due to the expansion of engineering knowledge.

At the same time feats of engineering had brought about the large industrial plants which required large orders to keep them working and here business training of the heads of industry was essential to regulate the industry so that the demand would not be overstepped by supply.

Although the two systems of training, for business life and for engineering, were widely separated, there was an interrelationship necessary to keep stability in world conditions.

Because of the variation in the outlook that was created by the two schools of training, the successful engineer seldom became the executive head of even an engineering firm. At the same time the old school business executive with no understanding of the laws of technology was unable to cope with the intricate mechanism that business had become.

The two departments of science and business training were more nearly associated than ever before. Even those with technical education were finding it necessary to learn the laws of business men to acquire the technical knowledge of an engineer to properly gauge business expansion.

A vote of thanks was proposed by W. C. Miller, M.E.I.C., seconded by J. A. Vance, A.M.E.I.C., and unanimously carried.

The evening was enlivened by cards and music provided by Colonel Murray Dillon and his Vimy Orchestra.

About sixty members and guests were present.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

The Montreal Branch Unemployment Relief Committee wishes to acknowledge, with thanks, receipt of an anonymous subscription for twenty dollars.

Machine Gas Cutting in Fabrication

On the evening of January 7th, 1935, the members of the Montreal Branch were the guests of the Montreal Chapter of the American Society of Metals at a practical demonstration and lecture held at the Dominion Bridge Company plant at Lachine.

The demonstrations included actual production work on oxy-acetylene gas cutting machines and metal spraying. Mr. R. F. Helmkamp, of the Air Reduction Sales Company, New York, later gave an illustrated talk on machine gas cutting. About five hundred attended. Previous to the meeting a dinner was held at the Windsor hotel at which F. P. Shearwood, M.E.I.C., the President of The Institute, gave a short address.

Annual Meeting—Montreal Branch

The annual meeting of the Montreal Branch was held on January 10th, 1935. Dr. A. Frigon, M.E.I.C., the chairman of the Branch, presided. J. G. Hall, M.E.I.C., chairman of the Papers and Meetings committee, spoke on the work of his committee during the past year, expressing the hope that members would continue to offer suggestions with regard to subjects for meetings, new activities, etc.

H. G. Thompson, A.M.E.I.C., read the report of the scrutineers, advising that F. S. B. Heward, A.M.E.I.C., had been elected chairman, J. B. D'Aeth, M.E.I.C., vice-chairman, and R. H. Findlay, M.E.I.C., B. R. Perry, M.E.I.C., and J. A. Lalonde, A.M.E.I.C., members of the executive for the year 1935.

After a vote of thanks to the outgoing executive, the newly-elected chairman gave a short talk on the progress of engineering during the past century.

G. McL. Pitts, A.M.E.I.C., then spoke on his proposed scheme for the consolidation of The Engineering Institute and the various professional associations. The details of this were further outlined by R. F. Legget, A.M.E.I.C. Due to the late hour it was decided to call a special meeting to deal with the discussion of this subject.

Refreshments were served at the close of the meeting.

Junior Section Annual Meeting

H. J. Leitch, A.M.E.I.C., presided at this meeting held on January 14th, 1935. The Secretary read the minutes of the last annual meeting, and a report of activities for the past year. Mr. D'Aeth, vice-chairman of the Montreal Branch, then spoke briefly on ways in which the section could be of assistance to The Institute.

The elections of officers resulted as follows: E. R. Smallhorn, A.M.E.I.C., chairman, L. A. Duchastel, Jr.E.I.C., vice-chairman, C. E. Frost, secretary, and the committee of Messrs. P. Poitras, A. Shearwood, S.E.I.C., J. S. Lochhead, McGill representative, L. P. Cousineau, S.E.I.C. and Felix Racicot, Ecole Polytechnique representatives, H. J. Leitch, A.M.E.I.C., and C. K. McLeod, A.M.E.I.C., ex-officio.

The new chairman, Mr. E. R. Smallhorn, presided at the discussion introduced by Mr. P. Poitras on "Codes of Ethics for Engineers." This provided a lively discussion during which many of those present expressed their views.

At the close of the meeting refreshments were served.

Noise Limit in Communication

Dr. O. E. Buckley, Director of Research in the Bell Telephone Laboratories, New York, spoke on the subject of noise on January 17th, 1935.

According to the speaker it was noise more than sensitivity that set the limits of hearing and serious attempts were being made to cut out this nuisance at its source. Radio static, telephonic and radio communication were also discussed.

Surveying and its Relation to Property

The first surveyor to receive a commission as such in Canada was Jean Bourdon, in 1634, stated C. C. Lindsay, A.M.E.I.C., of the firm of M. D. Barclay, Inc., in a talk before the Montreal Branch on January 24th, 1935. The speaker gave a summary of the laws affecting real property, discussing such questions as land titles and squatters' rights and the rights of property owners to what was above and below the soil.

Electrical Section—Boulder Dam Transmission Line

On January 25th, 1935, Mr. E. W. Titus, chief engineer of the Canada Wire and Cable Company, spoke on the manufacture and tests of the hollow core conductor as used in the Boulder dam transmission line. Slides and moving pictures illustrated the construction of the dam and line.

Mr. J. L. T. Martin was in the chair.

Junior Section—Plant Visit

On the evening of Monday, January 28th, 1935, the Junior Section of the Branch visited the Fire Alarm Control Headquarters of the city of Montreal on Fletcher's Field. Fifty members attended and these were divided into groups and conducted over the building by members of the staff.

This visit was arranged through the kindness of C. J. Desbaillets, M.E.I.C., chief engineer of the Montreal Water Board.

Special Meeting—Montreal Branch

On January 30th, 1935, at 8.30 p.m., a special meeting of the Branch was held in The Institute hall to discuss the proposals of G. McL. Pitts, A.M.E.I.C., for the consolidation of The Institute and the provincial professional associations.

R. F. Legget, A.M.E.I.C., outlined the proposal stating that measures should be taken along the lines suggested, at once.

F. P. Shearwood, M.E.I.C., President of The Institute, then spoke giving a résumé of his views, information and ideas he had obtained from his visit to all the branches of The Institute throughout Canada during the past year. In his opinion, Mr. Pitts was much too pessimistic of the outcome of negotiations when following the present procedure of Council.

P. L. Pratley, M.E.I.C., who was unable to be present, had prepared a résumé of Council's activities over the past fifteen years in endeavouring to secure uniformity of ideas between The Institute and the professional associations with a view of eventually forming a Dominion body. In this connection The Institute had taken the initiative throughout. This was read by F. Newell, M.E.I.C., for Mr. Pratley.

J. L. Busfield, M.E.I.C., then pointed out some of the likely stumbling blocks in Mr. Pitts' scheme and proposed an alternative.

This led to considerable discussion after which a motion was carried that a resolution should be sent to the coming Annual Meeting of The Institute recommending that immediate steps be taken to approach the professional associations with a view to obtaining a co-ordination of activities of the two bodies.

F. S. B. Heward, A.M.E.I.C., presided.

Modern Arc Welding

David Boyd, A.M.E.I.C., assistant works manager of the Dominion Bridge Company, Lachine, discussed, on January 31st, 1935, the properties of the electric arc, electrodes, weld metal and outlined fields of application. The qualifications and training for operators and inspectors were also set forth.

H. J. Roast, M.E.I.C., acted as chairman.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The Branch held a dinner meeting at Thorold on January 22nd, 1935, gathering at the new plant of "Spun Rock Wools Ltd." and later being addressed by Mr. C. R. Buss on the subject of "Insulation."

PLANT VISIT

The plant, which is a new industry to this country, is quite compact; containing two electric furnaces that alternate in producing the fluffy material which is now being used for house and other forms of insulation. The stone is obtained locally and is used without any additional ingredient. Although the process appears to be extremely simple yet a great many experiments had first to be made in order to achieve the exact furnace temperatures, lining materials and speeds whereby these results were attained. It differs from previous methods in that the rock is electrically smelted and the wool fibre formation is effected by means of a rapidly rotating disc instead of air or steam blowing. The result is a fine light fibre practically free from any impurities or non-insulating matter, being fire and insect proof, with a weight of 6 pounds per cubic foot and a conductivity of 0.25. It is shipped in bulk form or in bats and rolls.

An evening meeting of the Branch was held at Thorold on February 15th, 1935, at which Mr. J. M. Barclay, vice-president of the southwestern branch of the Amateur Athletic Union, spoke upon the subject of games as an aid to character building.

Children are particularly helped by organized games, they learn to give and take, to be fair, to develop their will power and to acquire balanced power and judgment.

When the children absorb true principles of sport, the nations to which they belong become great. The Greeks and Romans were examples of nations which achieved greatness at a time when the chief honours were showered upon athletes. The process of decay started when sport became subservient to the flesh pots. "Waterloo was won upon the playing fields of Eton," and Britain will remain in the lead so long as she lives up to this tradition.

Chairman W. R. Manock, A.M.E.I.C., conveyed the thanks of the meeting to the speaker and then brought forward a discussion upon the merits of the E.I.C. Employment service. Several suggestions were advanced for possible improvements and it was resolved to bring these to the attention of the General Secretary and seek his advice.

L. P. Rundle, M.E.I.C., then gave a résumé of the activities at the annual meeting in Toronto, which was followed with close attention by those of the members who were unable to be present at that gathering.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

ANNUAL BRANCH MEETING

The twenty-fifth annual meeting of the Ottawa Branch of The Engineering Institute of Canada was held at the rooms of the Canadian Government Motion Picture Bureau, Sussex and John streets, on the evening of January 10th, 1935. About sixty-seven members were present, the retiring chairman, A. K. Hay, A.M.E.I.C., presiding. F. C. C. Lynch, A.M.E.I.C., Branch secretary, was present to carry out the duties of that position.

The chairman, in presenting his address, reviewed the activities of the Branch for the past year, and paid tribute to the work of his immediate predecessor, Group Captain E. W. Stedman, M.E.I.C. During the year the attendance at the luncheons had been well maintained, and at the evening meetings had been beyond expectations.

The chairman referred to the fact that all branches of The Institute had received suggestions that more consideration should be given to the younger members. This matter had been carefully thought over and constructive suggestions on this point would be welcomed by the management committee. More written contributions or papers from younger men would be most desirable and the Proceedings committee would arrange for meetings where any group of members might discuss some particular subject, whether of general interest or otherwise.

The secretary-treasurer's report revealed that the finances of the Branch were in good condition with a cash balance (including bank balance, cash on hand and Government Bonds) of $1,669.54 and total assets of $1,733.44. Deaths, resignations and members removed from the roll, resulted in a decrease in membership of 21, the total now being 326 resident and 59 non-resident members. The death was recorded with deep regret of two members: S. Bray, M.E.I.C., and W. C. Treanor, A.M.E.I.C.

The secretary-treasurer's report also recorded that in accordance with the motion passed at the last annual meeting, the Branch donated two sets of draughting instruments to the Ottawa Technical School for presentation as prizes for proficiency in draughting, and a copy of "Standard Handbook for Electrical Engineers" to the Hull Technical School for presentation as a prize to a student in the Department of Electricity. John McLeish, M.E.I.C., on behalf of the Branch, personally presented the prizes to the successful students at the annual commencement exercises of the Ottawa Technical School on December 7th last.

Twelve luncheon meetings were held by the Branch, five evening meetings including the annual Branch meeting, and one afternoon was devoted to a visit to the studios and transmitting station of CRCO. The average attendance at the luncheons was sixty-nine and at the evening meetings sixty-two. Some suggestions were put forward in the report of the proceedings committee for the consideration of the incoming executive with regard to luncheon arrangements.

The aeronautic section held eight meetings of their own and were also extended invitations to attend eight other meetings held under other auspices in which subjects of direct interest to them were presented. With this section, which has a membership of ninety-five, is incorporated the Ottawa Section of the Royal Aeronautical Society. It receives a small grant from the Ottawa Branch of The Engineering Institute of Canada. During the year the chairman was Group Captain E. W. Stedman, chief aeronautical engineer of the Department of National Defence, and the secretary was K. F. Tupper, of the National Research Council.

The reports of committees presented, after the chairman's address and the secretary-treasurer's report, were:—

Proceedings committee by J. H. Parkin, M.E.I.C.
Membership committee by W. F. M. Bryce, A.M.E.I.C.
Unemployment committee by G. J. Desbarats, M.E.I.C.
Rooms and Library, Branch By-laws and Reception committee by J. G. Macphail, M.E.I.C.
Advertising committee by A. V. Gale, A.M.E.I.C.
Aeronautic section by E. W. Stedman, M.E.I.C.

After the committee reports a resolution was passed to the effect that the policy be continued for the school year of 1934-35 of donating prizes to students of the Ottawa Technical School and the Ecole Technique de Hull for proficiency. A resolution was passed that the thanks of the Branch be conveyed to the Ottawa Journal, the Ottawa Citizen, and Le Droit for the publicity given to proceedings during the year.

Following a suggestion by C. Klotz, S.E.I.C., that greater attention be paid to new members, a discussion took place with regard to how interest amongst these new members could be encouraged. Group Captain Stedman advised the meeting of the procedure followed by societies in England and out of the discussion certain suggestions were put forward for the consideration of the incoming executive with a view to effecting this result.

C. M. Pitts, A.M.E.I.C., reported as councillor on the work of the Council, the main item of which during the past year was the work of the Development Committee. He expressed the opinion that it was most important to The Institute that the matter of greater cooperation between our Institute and other engineering bodies should not be allowed to drop. To this end he presented a resolution, seconded by John Murphy, M.E.I.C., to the effect that the Ottawa Branch go on record as supporting any movement towards uniting the Professional Engineering organizations in each province and ultimately throughout the Dominion of Canada; also that the General Secretary of The Institute be sent a copy of this resolution and an expression of support of the Ottawa Branch to any movement along this line, the General Secretary to be requested to present such communication to the Annual Meeting of The Institute to be held in February next. After some discussion the motion was carried.

The report of the election for the ensuing 1935-36 year was then announced.

Mr. Hay then introduced Dr. R. W. Boyle, M.E.I.C., the chairman for 1935, who took the chair and expressed his thanks for the honour which had been conferred upon him by the Ottawa Branch. After a vote of thanks had been moved for each of the retiring officers of the Branch, the annual meeting closed with the showing of a motion picture "Flying over the Empire" secured through the courtesy of the National Council of Education, after which refreshments were served.

HIGH TENSION DIRECT CURRENT TRANSMISSION

The first evening meeting of the new 1935 term took place January 24th at the Auditorium of the National Research Laboratories. B. G. Ballard, B.Sc., A.M.E.I.C., of the National Research Council, was the speaker, his subject being "Some Aspects of High Tension Direct Current Power Transmission." Dr. R. W. Boyle, M.E.I.C., newly elected chairman of the Branch, presided.

Of all the methods in practical use for the transmission of power, stated Mr. Ballard, electric transmission is the only one employing alternating or oscillating forces. The reasons for its adoption are well known. It would not be impossible to transmit mechanical power in a similar manner using alternating impulses but the fact that inertia effects would demand larger equipment for the same amount of power input would be a much greater disadvantage relatively in alternating mechanical transmission than in alternating electrical transmission.

In alternating current transmission, the power flow in any one element varies from zero to some maximum value which, of course, is somewhat higher than the net effective value. This factor has little importance when currents are considered but with voltages it is different. It necessitates that the system insulation must be capable of withstanding the maximum peak voltages encountered. In practice it is found that direct current effective voltages may safely be as much as 100 per cent higher than alternating current effective voltages.

Another apparent advantage in direct current high voltage transmission is that corona losses are less than with alternating currents. This reduction may be as much as 50 per cent less for a given effective voltage in the case of 25 cycle lines.

Thury developed the direct current system in Europe and in one instance built a line over 100 miles in length, operating at 70,000 volts. The system operates at a constant current rather than at constant voltage, and, incidentally, avoids much of the trouble due to surges so frequently encountered on direct current systems for railroad electrification. The advantages are: higher effective voltages; unity power factor; and no dielectric losses. The disadvantages are: generating units economically too small, owing to limitations imposed by commutators; generators require insulated bases and couplings; and full load line copper loss at all times.

These handicaps have prevented any appreciable extension of the Thury system.

Recent developments, however, have renewed activity in direct current power transmission. Among those giving most promise is the vapour discharge tube. With this it is hoped to rectify alternating currents at high voltages, transmit over long lines by direct current, then invert through other vapour discharge tubes to alternating current which could be stepped down in ordinary transformers to usable voltages.

At present, currents of many amperes may be controlled with tubes little larger than radio tubes. Moreover, in addition to rectifying, the tubes may be made to control voltages without losses and to operate as circuit breakers with either instantaneous or time delay overload trips.

At this point the speaker demonstrated the use of such tubes with apparatus specially set up for the occasion. He also referred to advantages and disadvantages of the vapour discharge tube as opposed to the high vacuum tube, and the limitations of commutator design which prevented rotating direct current machines from operating at voltages much higher than 5,000. There are possibilities that such limitations may be met in a practical way by operating the machines in a vacuum.

At present research is mainly along the lines of overcoming these limitations and of minimizing the effects of surges so commonly prevalent in direct current systems.

The address was followed by a period of discussion after which refreshments were served.

Peterborough Branch

H. R. Sills, Jr.E.I.C., Secretary.
E. J. Davies, Jr.E.I.C., Branch News Editor.

MODERN ARC WELDING

The principles and practice of the manual art of arc welding was the subject of an address by Mr. David Boyd of the engineering staff of the Dominion Bridge Company, Montreal, to this Branch at the regular monthly meeting on Thursday, January 10th, 1935.

Engineers of to-day have developed welding by the use of oxy-acetylene gas, thermit and electricity and with virtually all metals.

As is generally known, arc welding has displaced riveting in many directions. Its application in the manufacture of tanks, hoppers and also in general shop work, in the fabrication of large sized pipe, in replacing steel castings and especially in structural iron work, covers a wide range of successful adaptations. Mr. Boyd rather pointedly declared that some designing engineers have been slow to recognize the effectual use of arc welding in its fuller scope of replacing riveting, and cited from his own extensive experience examples of detail work, particularly in joints, in which welders have turned out more perfect jobs.

In the field of iron pipes of larger diameters electric welding is supreme. It has revolutionized the manufacture of high pressure vessels especially in the petroleum industry, where high pressures and high temperatures are required in what are called "cracking" stills. Danger of leakage of petroleum and crude oil products from the vessels in which they are reduced has been eliminated by welding, which also has permitted the use of heavier plates in such vessels, thereby paving the way for higher pressures and greater heat.

Welded joints behave consistently under tests, Mr. Boyd said, giving a uniform performance in any structure. The designing of welded joints is a new art that is being continuously improved. Mr. Boyd's screen slides illustrated much of his subject matter, and its practical phases were thoroughly appreciated by the men who are engaged in this work.

There was an exceptionally good attendance including members and many visitors who are welders from the local factories, and others interested in welding. A vote of thanks and appreciation of Mr. Boyd's very interesting address was tendered by O. R. Thompson, M.E.I.C., of Belleville.

Saskatchewan Branch

S. Young, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Saskatchewan Branch of The Engineering Institute of Canada, was held in the Saskatchewan hotel on Thursday evening, January 24th, 1935, at 7.45 p.m., being preceded by a dinner. The total attendance was twenty-five. The guest speaker of the evening was William Storrie, M.E.I.C., consulting engineer, Toronto.

Immediately following the dinner several songs were contributed by Mr. Sam Swayze.

Dr. B. C. Riley, of the staff of the General Hospital, spoke for a few minutes on the treatment of frozen parts of the body by the mechanical application of positive and negative atmospheric pressures, an entirely new method.

The Secretary read a letter from R. J. Durley, M.E.I.C., advising of the election of H. S. Carpenter, M.E.I.C., as a life member of The Institute and another advising of the temporary continuation of the five dollar entrance fee for the grade of Junior and higher classes, thus eliminating the transfer fee when transferring from Junior to Associate or from Associate to Member.

S. R. Muirhead, A.M.E.I.C., reported for the Papers committee, stating that arrangements had been completed to have E. E. Lord address the annual meeting in March on his experiences in engineering work in China.

The acting chairman, A. P. Linton, A.M.E.I.C., then introduced the guest speaker, William Storrie, M.E.I.C., his subject being the "Engineer and Public Health."

After briefly outlining the work of the engineer in its relation to public health, Mr. Storrie proceeded to detail the activities of the engineer in respect of water supply and sewage disposal. Following this numerous lantern slides were shown depicting the construction of waterworks and sewage disposal plants at various points, particularly the city of Toronto where Mr. Storrie was engaged as consultant. The address was provocative of considerable discussion, following which a hearty vote of thanks was tendered to Mr. Storrie on motion of D. A. R. McCannell, M.E.I.C., and R. H. Murray, A.M.E.I.C.

Sault Ste. Marie Branch

H. O. Brown, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Sault Ste. Marie Branch was held at the Windsor hotel on Wednesday, January 23rd, 1935, in the form of a dinner-meeting with Frank Smallwood, M.E.I.C., the new chairman, in the chair.

Twenty-six sat down to dinner at 6.45 and about a dozen more came later for the business meeting and address.

After the business of the evening had been transacted the chairman called on O. A. Evans, Jr.E.I.C., of the Sault Branch, to address the meeting on "Theory and Practice of Assaying."

Mr. Evans is assayer for the Mines Department of the A.C.R. and is, therefore, well qualified to discuss his chosen subject. Samples of typical Algoma ores which are sent in for assaying and samples of assays in various stages of the process were shown throughout the paper.

A historical outline of the assaying of precious metals and the development through the ages was first presented. This was followed by a detailed description of the present "dry system" of assaying of gold and silver ores. The size of sample used; the crushing; and flux elements used and the heating and segregation of "the button" were all explained very thoroughly, and as previously mentioned were illustrated with actual working samples.

At the close of the paper various questions were asked and explained by Mr. Evans. After the discussion a very hearty vote of thanks was tendered Mr. Evans by the members and friends present.

Mr. Smallwood then spoke briefly and solicited the support of the members for the coming year by their attendance and help on the various committees. He also made reference to the prospects for new members and in this connection the membership committee would appreciate having members submit the names of any who are eligible to become members.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.
E. V. Caton, M.E.I.C., Branch News Editor.

A meeting of the Winnipeg Branch of The Engineering Institute of Canada was held in the University Buildings, Broadway, on Thursday January 3rd, 1935.

At the request of the acting chairman, Professor A. E. Macdonald, A.M.E.I.C., introduced the speaker of the evening, Rev. A. E. Kerr, pastor of Augustine Church, Winnipeg, who delivered a most informative and entertaining address under the title "Personal Impressions of Russia."

Mr. Kerr began by stating that he laid no claim to being an authority on Russia, but that he had been able to gratify a long-felt wish by visiting Russia in the summer of 1934; entering by way of Leningrad, visiting Moscow and the Ukraine, and leaving by way of Odessa. He had been able to come into fairly close contact with the people of Russia, other than officials, and had therefore been able to gain some very interesting sidelights on the conditions of the country.

In 1928 the Five Year Plan was launched, with the remarkable result that at the end of the first five years heavy industry in Russia had been doubled. But it is to be noted that in spite of the pressure that was brought to bear upon agriculture and with the advent of thousands of tractors and modern farm implements, at the end of the Five Year Plan the amount of livestock in the country had been reduced to 50 per cent of what it had been in 1917. The reason given for this was that the individual farmers failed to co-operate with the government in the manner and to the extent that had been expected of them. Several incidents related by Mr. Kerr touching on the treatment of the farmers left no doubt as to the cause of such lack of co-operation.

At the close of his address Mr. Kerr very kindly answered numerous questions asked by the members. J. W. Porter, M.E.I.C., moved a hearty vote of thanks to the speaker.

A special meeting of the Winnipeg Branch of The Engineering Institute of Canada was held on Friday, January 25th, 1935.

The speaker of the evening was William Storrie, M.E.I.C., of Messrs. Gore, Nasmith and Storrie, consulting engineers, Toronto, who gave an extremely interesting address on water supply and sewage disposal, describing installations with which he had been connected in Toronto and other eastern cities; also in Calgary. The address was illustrated by lantern slides.

Mr. Storrie pointed out the work done by the engineering profession in preventative medicine and in the improvement and protection of public health, both as regards to supply of safe drinking water and the adequate disposal of sewage. His discussion of the difficulties to be met in different installations was extremely interesting and at the close of his talk the active discussion which took place indicated the interest of the members in the matter.

A hearty vote of thanks was tendered the speaker for his interesting address.

Association of Professional Engineers of the Province of Manitoba

The annual meeting of the Association of Professional Engineers of the Province of Manitoba was held in the Hudson's Bay dining room on Thursday, January 17th, 1935.

Previous to the meeting a dinner was held.

The guest speaker of the evening was the new Chief of Police, Mr. Geo. Smith, who gave an interesting address on police matters.

The report of the scrutineers showed that 134 valid ballots were received, and Messrs. J. N. Finlayson, M.E.I.C., J. W. Sanger, A.M.E.I.C., J. A. Meindl, A.M.E.I.C., and G. E. Cole, A.M.E.I.C., were elected as the new Councillors for the term ending January, 1937. The three members of Council still having one year to serve are Messrs. E. W. M. James, A.M.E.I.C., A. L. Cavanagh, A.M.E.I.C., and C. S. Landon.

Following the report of the scrutineers Council retired from the general meeting and held its Organization Meeting.

The report of Council showed that the membership at December 31st, 1934, stood at 202.

The report of the secretary and auditors showed very satisfactory condition of the finances; the bonds of the Association having a par value of $10,100.

Council appointed J. W. Sanger, A.M.E.I.C., as its representative on the Committee of Eight for 1935.

The Association and Institute Joint Committee on Unemployment had during the year continued the very valuable work commenced three years ago and had been successful in securing work for a number of unemployed engineers, and felt that as a result of their negotiations the reputation of the engineering profession had been enhanced, particularly with certain departments of the government.

The question of ways and means of more active co-operation between the two organizations in Manitoba was thoroughly discussed, following which the incoming Council was instructed to appoint a committee to further this work.

A Committee from Council reported that they had interviewed provincial government officials as regards seeing that engineers employed in the mining industry in the province were registered members of the Association where their work came within the meaning of the Act.

W. M. Scott, M.E.I.C., chairman of the University Scholarship Committee, reported that the annual scholarship of the Association granted to the student of the second year in engineering of the University of Manitoba who obtained the highest aggregate on the results of the first and second years, was awarded this year to Mr. Eliot R. Davis, of Winnipeg.

The new President, Professor J. N. Finlayson, then took the chair, and in a few well chosen remarks closed the meeting.

The meeting adjourned at 11.40 p.m.

The McCharles Prize, 1935

Announcement is made that an award of the McCharles Prize, instituted by the University of Toronto, will shortly be considered. This is a distinguished prize for engineers, inventors and scientific research workers. It carries not only a very high honour but a cash value of one thousand dollars.

This prize was established in connection with the bequest of the late Aeneas McCharles of the value of $10,000 and is awarded on the following terms and conditions contained in the bequest and authorized by the governors of the University of Toronto, namely, that the interest therefrom shall be given from time to time, but not necessarily every year, like the Nobel prizes in a small way:

(1) To any Canadian from one end of the country to the other, and whether student or not, who invents or discovers any new and improved process for the treatment of Canadian ores or minerals of any kind, after such process has been proved to be of special merit on a practical scale; (2) or for any important discovery, invention or device by any Canadian that will lessen the dangers, and loss of life in connection with the use of electricity in supplying power and light; (3) or for any marked public distinction achieved by any Canadian in scientific research in any useful practical line.

The term "Canadian" for the purpose of the award means any person Canadian born who has not renounced British allegiance, and for the purpose of the award in the first of the three cases provided for by the bequest, domicile in Canada is an essential condition.

Every candidate for the prize is required to be proposed as such in writing by some duly qualified person. A direct application for a prize will not be considered.

No prize will be awarded for any discovery or invention unless it shall have been proved to the satisfaction of the awarding body to possess the special practical merit indicated by the terms and spirit of the bequest.

The committee of award announces that it will receive nominations for candidates up to the 1st April next. Nominations may be made direct to Dean C. H. Mitchell, M.E.I.C., chairman of the committee, at the University of Toronto.

Engineers and The Empire

The novelist and the poet not uncommonly regard their outpourings, when they have been translated into type, with a coldness and even an aversion that the layman finds astonishing. It is not surprising, therefore, to find that the engineer, while he may pore for hours over his drawings and exercise all his energies in seeing that construction is carried out in accordance with his ideas, is by no means always willing to set down what he has done on paper for the benefit of his colleagues, still less to expatiate to a lay public. Moreover he has not been too well treated by the historian and, with almost the single exception of Mr. Kipling, the novelist has also neglected that romance which, in the widest sense "brings up the 8.15." It was therefore fitting that the Royal Empire Society should have devoted their meeting in London, on January 15, to a consideration of what engineers have done for the Empire, and that they should have called on such distinguished representatives as Mr. Ralph Freeman, Mr. Julian Tritton, Brigadier-General Hammond and Colonel Pollard-Lowsley to tell them something about their work. The result must have been to show how much such structures as the Sydney Harbour Bridge, the Willingdon Bridge at Calcutta, the Hardinge Bridge over the Ganges, and the Zambesi Bridge, the development of such ports as those at Haifa, the construction of many miles of railways in India, Ceylon, Malaya, West Africa and Uganda and, perhaps above all, the lay-out of extensive irrigation systems in more than one of the King's Overseas Dominions, have done to save life, and both materially and morally to raise the standard of living. To illustrate this opinion, only one quotation, taken from Colonel Pollard-Lowsley's address, is necessary. In India, he said, as the result of the work of British engineers, an area of 49,451 square miles had been irrigated, constituting one eighth of the cultivated area of the sub-continent.—*Engineering.*

International Housing and Town Planning Congress

The fourteenth International Housing and Town Planning Congress is to be held in London, England, on July 16th to 20th, 1935. This is arranged by the International Federation for Housing and Town Planning, 25 Bedford Row, London, W.C.1. The Congress has the support of the British Government, the Corporation of the City of London, the London County Council, other leading municipalities and the national associations concerned with housing and town planning.

A most interesting programme of meetings and inspection trips has been arranged.

Canadian Institute of Mining and Metallurgy

The 1935 Annual Meeting of the Canadian Institute of Mining and Metallurgy is to be held at Winnipeg, Man., on March 12th to 14th next. The visitors will be entertained at the Royal Alexandra hotel in Winnipeg by the local mining group, who are now of substantial numbers, and an excursion by special train to Flin Flon has been arranged.

The first annual meeting of the Canadian Institute held in Winnipeg was in 1929, when the mineral industry of the province of Manitoba was just beginning to be firmly established. During the intervening six years one of the world's great mines has been put into operation at Flin Flon, and San Antonio and other gold mines have become a substantial and dependable source of gold. Thus the return of this important annual convention to Winnipeg marks the definite entry of Manitoba into the mining history of the Dominion.

The General Motors of Canada report that on February 1st, 1935, their Oshawa plant showed an increase of 45 per cent over the number of men employed on the same date of 1934. At the Walkerville engine plant of the company, employment showed a gain of over 48 per cent. The McKinnon Industries unit of General Motors, at St. Catharines, producer of gears and electrical units, showed an increase of 24 per cent. The total number of direct employees on the payroll of General Motors of Canada at January 31st, was sixty-six hundred.

Preliminary Notice

of Applications for Admission and for Transfer

February 26th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in April, 1935.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

CHENEVERT—JOSEPH GEORGES, of 555 Querbes Ave., Outremont, Que., Born at Montreal, March 19th, 1900; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1923; From 1923 to date, with Arthur Surveyer & Company, Consltg. Engrs., Montreal, on design and supervision of numerous large bldgs., filtration plants, aqueducts and sewage disposal plants, valuations, studies re establishment of various plants, investigations and reports, also expert in court cases, etc., and at present consltg. engr. with above company.

References: A. Surveyer, O. O. Lefebvre, A. Frigon, J. B. Challies, E. A. Ryan, R. P. Raynsford, H. Massue, E. Nenniger.

EWART—HENRY EDWARD, of 243 First Ave., Ottawa, Ont., Born at Ottawa, Ont., March 11th, 1878; Educ., Walton and Bridges Private School, Ottawa, 1891-94. Matriculation; 1894-96, architectural dfting and practical experience under D. Ewart, chief architect, Dept. Public Works; 1896-99, practical experience on constrn. of Halifax Armories, full size working drawings, templates, erection of derricks and all trades; 1899-1902, asst. res. architect, Yukon Territory; 1902-04, private practice as architect, Yukon Territory; 1904-06, Member, Architectural and Engineering Co. of Canada, in charge of Winnipeg Branch; With Royal Mint, Ottawa, as follows: 1906-08, in charge of equipment; 1908-19, second technical officer; 1919-24, senior technical officer; 1924-27, engr.; 1927-31, chief technical officer, and 1931 to date, supt., Royal Canadian Mint, Ottawa, Ont.

References: J. L. Busfield, K. M. Cameron, L. L. Bolton, J. McLeish, C. M. Pitts.

GODSON—REGINALD GILBERT, of 28 Summerhill Gardens, Toronto, Ont., Born at Pietermaritzburg, Natal, South Africa, May 7th, 1897; Educ., 1916, Sch. of Military Engrg., Chatham, and 1921-24, special course at Cambridge Univ. (Peterhouse College) and School of Military Engrg., Chatham; 1916-18, Commn. in Royal Engrs., France; 1919-20, Divnl. Officer, R.E., South Palestine; 1920-21, Divnl. Officer, R.E., Helmich and Upper Egypt; 1924-26, Garrison Engr., North West Frontier Province, India; 1926-28, half pay list—deafness contracted in Great War. Retired 1928; 1926-27, designing engr., Lachine, 1927-29, designer, city office, Dominion Bridge Company; 1929-34, designing engr., Robb Engrg. Works, Amherst, N.S. (Subs. of Dominion Bridge Company).

References: C. R. Young, J. M. Oxley, C. S. Kane, J. F. F. MacKenzie, R. C. Manning.

HERBISON—WILLIAM, of 167-8th Avenue, Lachine, Que., Born at Clydebank, Scotland, Jan. 9th, 1905; Educ., 1919-25, Royal Technical College (Cert.); 1926-27, Struct'l. design, 1933-34, reinforced concrete design, Montreal Technical Institute; 1927-28, 1931-32, struct'l. design course, Dominion Bridge Co.; Private tuition, 1935; 1919-21, junior dftsman., engine dept., and 1921-26, shop ap'tice in marine engine dept., including assembling and testing steam and Diesel engines, John Brown & Co. Ltd., Engrs. and Shipbldrs., Clydebank, Scotland; 1926 to date, dftsman., Dominion Bridge Company, Lachine, preparing and checking details for bldgs., rly. and highway bridges, swing bridges, turntables, hydraulic regulating gates, boilers and pressure vessels.

References: F. P. Shearwood, F. Newell, D. C. Tennant, A. S. Wall, P. Millar, A. Peden, V. R. Davies.

HUGGINS—MARK WILLIAM, of Dundas, Ont., Born at Toronto, Ont., March 19th, 1911; Educ., M.A.Sc., Univ. of Toronto, 1933; 1930 (summer), rodman, city of Toronto; 1931 (summer), field engr., Consumer Gas Co., Toronto; 1932-33, research asst., Univ. of Toronto; 1933 to date, engr., E. P. Muntz Ltd., Dundas, Ont., largely research studies and tests.

References: E. P. Muntz, C. R. Young, G. G. Powell, E. H. Darling, F. W. Paulin.

KEMP—CECIL GEORGE, of 2376 Melrose Ave., Montreal, Que., Born at Dartford, Kent, England, May 15th, 1897; Educ., 1909-12, Sydney Technical College. Awarded N.S.W. State Gold Medal in 1912 for highest marks in machine design; 1913-17, ap'ticeship in mech'l. engrg., Wm. Thornley & Sons, Gen. Engrs., Sydneyham, N.S.W.; 1917-19, on active service with A.I.F.; 1919, dftsman, boiler and steam plant layouts, Babcock & Wilcox, Sydney; 1919-20, dftsman., elect'l. branch, N.S.W. Govt. Railways and Tramways; 1920-21, engrg. dftsman., mech'l. and struct'l. details, cold storage work and abattoirs, Frank Coxon & Son (Consltg. Engrs.), Sydney; 1921-23, designer and asst. engr., Rosebery Engine Works, Sydney; 1923-24, engrg. dftsman., Australian Gas Co., Sydney; 1924 (May-Nov.), private practice as engr. to Lysaghts Wire Works, and the Star Machy. Co., mech'l. and struct'l. design, bldgs. and machy.; 1924-26, designer and engr., Standard Portland Cement Co., design of two unit cement plant, also supervision of drawing office and constrn.; 1926-27, chief engr., Scanland Electric Co., design of structures, estimates, etc., asst. to man. director, Redfern, N.S.W.; 1929, engr. and estimator, E. G. M. Cape Co., Montreal; 1929-32, res. engr. and constrn. supt., Canada Cement Co. Ltd., Montreal; 1932, appraiser, General Steel Wares Ltd., plant and machy.; 1932-34, engr., D. Verochio, excavators and contractors, Montreal; May 1934 to date, constrn. supt. and engr., Consumers Glass Co. Ltd., Montreal, Que.

References—S. Barr, K. L. MacMillan, L. B. McCurdy, F. Kilbourn, W. G. H. Cam.

KERR—SAMUEL LOGAN, of 30 E. Mt. Pleasant Ave., Philadelphia, Pa., Born at Philadelphia, July 15th, 1899; Educ., B.S. in M.E., 1921, M.E., 1924, Univ. of Penn.; 1917 (summer), dftsman., I. P. Morris Co.; 1918-19, with U.S. Army, A.E.F. in France; 1920 (summer), asst. in charge of hydraulic testing lab. I. P. Morris Dept., Wm. Cramp & Sons Ship and Eng. Bldg. Co., Philadelphia; 1921-27, with I. P. Morris Dept. of above company as follows: 1921-22, research asst., special investigations and lab. testing in connection with hydraulic turbine manufacture. Also research investigation water hammer theory; 1921-24, engrg. investigations, proposals and estimating work on hydraulic turbines, field tests and investigations; guarantees and acceptance tests on turbines, including Queenston plant, H.E.P.C. of Ont., Great Falls plant, Manitoba Power Co., Station 3C, Niagara Falls Power Co., etc.; 1927-29, asst. chief engr., I. P. Morris Corpn., responsible charge hydraulic governor design; also field engrg. and testing completed installns. Developed "Automatic Operator" for speed and load control in hydro-electric generating plants; 1929-31, research engr., I. P. Morris & DeLavergne Inc., in responsible charge of research and experimental labs. for hydraulic turbines, pumps, governors, Diesel engines and refrigerating machy. Designed and constructed hydraulic turbine and governor labs. In responsible charge field testing all products and field service and constrn. hydraulic turbines and design of hydraulic governors. Member, N.E.L.A. Committee on Hydraulic Governors. Appointed Capt., Specialist Reserve, Ordnance Dept., U.S.A.; 1931 to date, research engr., I. P. Morris Divn., Baldwin Southwark Corpn., Philadelphia. Responsible charge lab. and field testing hydraulic turbines, governors and water works equipment; also design hydraulic governors and automatic control equipment. Responsible charge design and testing automatic water works valves. Development of new types and applications. Specializing in ana yses and solution of water hammer problems in water works systems. Chairman, A.S.M.E. Committee on Water Hammer; Member, A.S.M.E., Member, A.S.C.E.

References: J. A. Aeberli, R. W. Angus, T. H. Hogg, H. G. Acres, J. J. Traill, H. S. Van Patter, C. E. Herd, C. W. Larner, W. S. Pardoe.

LAPLANTE—RENE, of Montreal, Que., Born at Valleyfield, Que., June 13th, 1904; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1929. 1929-30, elect'l. engrg., Mass. Inst. Tech.; 1925, Dominion Geodetic surveying; 1926, Dominion Topographic surveying; 1928, reinforced concrete design, Baulne and Leonard; 1929, Quebec Streams Commn., asst. engr., supervision of dam constrn.; 1930-33, Shawinigan Water & Power Co., distribution system (operation and design), transmission lines (mtce.), meter dept., Shawinigan Falls power house (operating and testing); 1933-34, Shawinigan Chemicals Ltd., carbide lab. (research and design); 1934 to date, Shawinigan Water & Power Co., Montreal, asst. engr., electric rate making.
References: O. O. Lefebvre, A. Frigon, H. Massue, P. S. Gregory, R. H. Mather.

MEALS—CASPER DULL, of 233 Hillcrest Ave., Hamilton, Ont., Born at Harrisburg, Pa., April 15th, 1891; Educ., Drexel Institute, Philadelphia, 1918-19. Private tuition maths., mechanics, strength of materials, machine design and struct'l. engrg., 1910-17; 1911-19, dftsman., 1919-22, asst. engr., John A. Roeblings Sons Co., Trenton, N.J.; 1923-24, struct'l. dftsman., Bethlehem Steel Co.; 1922-23, chief engr., Wilcox, Crittenden & Co., Middleton, Conn.; 1924-25, sales engr., in Wilkes-Barre, Pa. and Penna. and W.Va. coal fields, 1926-27, asst. chief engr., New York office, and 1927-30, chief engr., American Cable Co.; 1930, chief engr., New York Cordage & Cable Co.; 1930-31, president and gen. mgr., Wire Rope Corpn. of America, New Haven, Conn.; 1931 to date, wire rope engr., B. Greening Wire Co. Ltd., Hamilton, Ont.
References: E. G. MacKay, W. Hollingworth, P. L. Pratley, C. N. Monsarrat, F. Newell, R. S. Eadie.

LEECH—JACK HAROLD, of 687 Gouin Boulevard, Montreal, Que., Born at Weston-super-Mare, England, Jan. 11th, 1895; Educ., 1902-10, Westmount Academy, Westmount, Que.; 1911-13, C.P.R., chainman, rodman, some instrument work on location and prelim. surveys; 1913-28, with Cedars Rapids Mfg. & Power Co., 1913-15, rodman and instr'man. on gen. constrn. work, and 1915 to 1928, looking after dredging operations and gen. constrn. work. Making plans for castings of all repair parts for dredges, drill boat and tugs. River studies under ice conditions; 1928-30, with Montreal Island Power Co.; 1928-29, looking after all constrn. work of power house and dams at St. Vincent de Paul, also sewer pumping stations, etc., and 1929-30, charge of all surveys in connection with flooding claims, also making of plans of properties. Study of ice conditions and flows, etc.; 1930, Montreal Light, Heat & Power Co., charge of constrn. of concrete foundations for river crossings at St. Timothee and Lasalle. Cedars-Atwater transmission line. Charge of all damage settlements also right-of-way settlements; 1930-32, Montreal Island Power Co., all survey work in connection with damage claims and looking after cases in court; 1932 (Aug.-Nov.), Montreal Light, Heat & Power Co., charge of constrn. of concrete foundations Turcot Yard transmission line crossing; 1932 to date, asst. to res. engr., Montreal Island Power Company, Montreal, Que.
References: G. P. Hawley, R. N. Coke, L. L. O'Sullivan, H. Milliken, J. F. Roberts, W. S. Lea.

SUITOR—WARREN DOUGLAS, of 332-6th Ave. N.E., Calgary, Alta., Born at Calgary, Jan. 15th, 1908; Educ., B.Sc. (E.E.), Univ. of Alta., 1934; Summers 1930 and 1933, and May 1934 to date, engrg. dept., Imperial Oil Refineries Ltd., Calgary, Alta.
References: R. S. L. Wilson, H. R. Webb, J. J. Hanna, J. Dow.

WINDSOR—MAURICE, of Ottawa, Ont., Born at Banbury, Oxon., England, June 30th, 1885; Educ., 1900-03, University College, London, England; 1904-06, shops, The Thomas Iron Works & Shipbldg. Co., Greenwich and Blackwall, England; 1906-07, shops, Hadfields Steel Foundry Co., Sheffield, England; 1908-12, engrg. staff and drawing office, The Daimler Motor Co., Coventry, England; 1912-13, inspection branch, Royal Army Service Corps., Aldershot; 1914-19, Aeronautical Inspection Dept., and Royal Flying Corps; 1919-22, engr. in charge of drawing office and inspection dept., Aircraft Mfg. Co. Ltd., London; 1922-24, Birmingham Small Arms Co. Ltd., England. Foreign representative for B.S.A. Guns Ltd., B.S.A. Tool Ltd., The Daimler Co. Ltd., W. Jessop & Sons, Sheffield; 1925 to date, Canadian manager and engr. in charge of aero engines and aircraft, at Ottawa works, for Armstrong Siddeley Motors Ltd., Ottawa.
References: C. Camsell, E. W. Stedman, J. H. Parkin, S. G. Tackaberry, W. R. Kenny.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

HOOVER—OWEN HUGO, of 1411-4A St., N.W., Calgary, Alta., Born at Port Hoover, Ont., Mar. 17th, 1888; Educ., B.A.Sc., Univ. of Toronto, 1912; 1909 (summer), prospecting and assisting in mine surveying at Cobalt and Welcome Lake, Ontario; 1910-11, dftsman., Can. Nor. Rly., Winnipeg; 1912-21, with Irrigation Branch, Dept. of the Interior, Calgary, 1912-13, asst. field engr., and 1913-21, junior hydrometric engr., in charge of field hydrometric district (except for overseas service, 1916-19); 1921-27, divn. hydrometric engr., Dominion Water Power Br., Dept. Interior, Calgary; 1927-32, divnl. hydrometric engr., and 1932 to date, engr. in charge, Dominion Water Power and Hydrometric Bureau, Dept. Interior, Calgary, Alta. (*A.M. 1921.*)
References: J. S. Tempest, S. G. Porter, P. J. Jennings, L. C. Charlesworth, P. M. Sauder, C. J. McGavin.

MILNE—WINFORD GLADSTONE, of 151 Deleware Ave., Hamilton, Ont., Born at Scarborough, Ont., June 16th, 1877; Educ., 1898-1902, Sch. of Practical Science, Univ. of Toronto; 1897 (summer), electric wiring, Lindsay Light & Power Co.; 1897-98, wiring motors, etc., W. H. Johnston Electric Co.; 1904-08, peat fuel manufacture; 1909-10, dfting., and 1910-19, plant engr., all plant and erection equipment, construction, and repairs, also elect'l. equipment; 1919-31, factory manager, for N. Slater Co., Hamilton, Ont., also in charge of all engrg. work, and from 1931 to date, gen. mgr. and vice-president of this company. (*A.M. 1919.*)
References: F. W. Paulin, R. K. Palmer, P. Ford-Smith, W. L. McFaul, W. F. McLaren.

PERRY—PHILIP CARLETON, of 2224 Cameron St., Regina, Sask., Born at Fort William, Ont., July 27th, 1889; Educ., Private tuition. Passed E.I.C. Exams. under Schedules B and C for admission as A.M. in 1920; 1906-10, chainman, rodman, and inspr., G.T.P. Rly., Fort William, Ont.; 1910-11, topographer and levelman, Algoma Central Rly.; 1911-14, dftsman., Fort William, 1915-18, rodman and instr'man., Edmonton, and 1918-20, res. engr., Regina, G.T.P. Rly.; 1920 to date, divn. engr., Can. National Rlys., Regina, Sask. (*A.M. 1920.*)
References: A. M. Macgillivray, D. A. R. McCannel, L. A. Thornton, A. P. Linton, H. S. Carpenter, C. J. Mackenzie.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BOWMAN—RONALD FRASER PATRICK, of Lethbridge, Alta., Born at Lethbridge, March 17th, 1904; Educ., B.Sc. (Civil), Univ. of Alta., 1928; 1920-25 (summers), rodman and chainman, Lethbridge Northern Irrigation Dist., New West Irrigation Dist., and Dept. Public Works. Alta., during 1925 doing instrument work; Summers 1926-27, and 1928-30, transitman, and 1931 to date, roadmaster, C.P.R., at present at Lethbridge, Alta. (*St. 1926, Jr. 1930.*)
References: R. S. L. Wilson, F. W. Alexander, T. Lees, J. M. Campbell, H. R. Miles, G. N. Houston.

BREAKEY—JAMES, of Brentwood Rd., Toronto, Ont., Born at Sheffield, England, Sept. 19th, 1901; Educ., Associateship in Engrg., Sheffield Univ., 1921; 1922, student in erection shops, Brightside Foundry & Engrg. Co., Sheffield; 1923-25, college ap'tice, at Metropolitan Vickers Electrical Co. Ltd., Manchester, England; 1925-27, with same company as asst. engr., on erection and inspection of mech'l. and elect'l. apparatus, and on design of power plants; 1927-29, sea-going engr. with A. Holt & Co., Liverpool, owners of the Blue Funnel Line (2nd Engr's. Board of Trade Cert. (Marine); 1929, dftsman., industrial drawing office, Canadian Vickers, Montreal; 1929 to date, editorial dept. of technical publications of the MacLean Publishing Co., being editor of Modern Power & Engineering and associate editor of Canadian Machinery and Manufacturing News. (*Jr. 1931.*)
References: C. B. Hamilton, Jr., R. E. Smythe, M. B. Watson, R. Ramsay, G. Agar.

RIDGERS—ARTHUR COURTNEY, of Rossland, B.C., Born at South Queensferry, Scotland, April 29th, 1901; 1916-22, H.M. Dockyard School, Portsmouth, England, and Technical Institute, Portsmouth. I.C.S. Course in Civil Engrg., 1924. Elected Struct'l. Engr., Assn. of Prof. Engrs. B.C. by Exam., Nov. 1934; 1916-22, ap'tice in constrn. dept., H.M. Dockyard, Portsmouth; 1922-24, asst. engr. at Havant, England, sewerage works constrn.; 1924-26, detailer, and 1926 to date, designing dftsman., Consolidated Mining & Smelting Co. of Canada Ltd. Responsible to chief engr. for design of zinc oxide leaching plant, phosphate fertilizer bldg., reconstrn. of zinc melting plant, design of structure, mercury arc rectifier bldg., proposed electrolytic zinc plant, for eastern Canada, design of all structures and layout of plant and equipment, etc. (*Jr. 1929.*)
References: H. Vickers, A. B. Ritchie, A. E. Wright, S. C. Montgomery, C. E. Marlatt.

FOR TRANSFER FROM THE CLASS OF STUDENT

BOWLES—WILLIAM SHEDDEN, of Westmount, Que., Born at Vancouver, B.C., June 12th, 1906; Educ., B.Sc. (Civil), McGill Univ., 1930. 1932-33, grad. studies, McGill Univ. leading to M.E. degree (not yet recd.); 1926-27 (summers), chainman and rodman, C.P.R.; 1928 (2 mos.), asst. operator, Cedar Rapids Power plant; 1929 (3 mos.), dftsman., Shawinigan Engrg. Co., Montreal; June 1930 to Nov. 1931, with A. F. Byers & Co., as manager of the Lamella Trussless Roof Co., sales, design and constrn. of Lamella roofs. Supervision during constrn. of swimming pool roof at Lucerne-in-Quebec. Layout engr. during constrn. of Foundry for Jenkins Bros. at Lachine. Business mgr. at Moncton, N.B., during constrn. of rink; Sept. 1933 to date, asst. to E. F. Tucker, A.M.E.I.C., Manager, Canadian Stebbins Engrg. & Mfg. Co. Ltd., estimating, design and gen. office work. (*St. 1929.*)
References: E. F. Tucker, A. F. Byers, E. V. Gage, C. H. Timm, J. A. McCrory, E. Brown, B. R. Perry.

MACDONALD—ARDEN MORRIS, of Londonderry Stn., N.S., Born at Truro, N.S., July 8th, 1912; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1933; 1929 (summer), asst. topographer, C.N.R., Moncton; May 1933 to June 1934, machinist installn. and mtce. of mining machinery for Prof. A. E. Flynn, N.S. Technical College, Halifax, N.S. (*St. 1931.*)
References: F. R. Faulkner, H. W. McKiel, F. L. West, A. S. Gunn, J. B. Hayes.

OGILVY—JAMES ANGUS, of 3129 Peel St., Montreal, Que., Born at Westmount, Que., June 7th, 1907; Educ., B.Sc. (Mining), McGill Univ., 1930; 1926 (summer), labourer on constrn. of Gatineau mill; 1927 (summer), rodman and temp. instr'man., Dome Mines Ltd.; 1929 (summer), machineman and slusher operator, Sullivan Mine, Cons. M. and S. Co. Ltd., Kimberley, B.C.; 1928 (summer), prospector, Nipissing Mining Co. Ltd.; 1930 (summer), inspr., mech. dept., Aluminum Co. of Canada, Arvida, Que.; With McIntyre Porcupine Mines Ltd., as follows: 1930-31 (6 mos.), helper, machineman; 1931 (Feb.-Apr.), engr. in charge of Birch Lake property during diamond drilling; May 1931, engr. in charge of party examining a staked area; Aug. 1931-Jan. 1932, sampler; 1932 (Feb.-July), engr. in charge of tests on rock drills, keeping cost and performance records; Aug. 1932 to Jan. 1933 and July 1933, acting shiftboss; 1933 (Feb.-June), shiftboss; Aug. 1933-June 1934, stope boss; 1934 (July-Nov.), mine supt., Thompson-Cadillac Mining Co. Ltd., Amos, Que. (*St. 1926.*)
References: A. Stansfield, A. D. Campbell, R. E. Jamieson, H. Idsardi, R. F. Ogilvy, W. L. McFaul.

PAMENTER—ARCHIBALD FRANCIS, of 14 James St., Dartmouth, N.S., Born at Liverpool, England, Aug. 2nd, 1905; Educ., B.Sc. (C.E.), N.S. Tech. Coll., 1932. N.S.L.S., 1925; With Hollingsworth & Whitney Ltd., Bridgewater, N.S., as follows: 1923 (3 mos.), chainman, rodman and instr'man., 1924-27, instr'man and land surveyor; 1927-28, N.S. land surveyor; 1929 (summer), N.S. land surveyor for N.S. Power Commn. on Mersey hydro line; 1930-31 (summers), dftsman., Acadia Gas Engrs. Ltd.; 1932 (3 mos.), N.S. land surveyor, Scott Paper Co. Ltd., Charleston, N.S.; 1932-33, private work as N.S. land surveyor; 1933 to date, in testing laboratory, Imperial Oil Co. Ltd., Dartmouth, N.S. (*St. 1931.*)
References: F. R. Faulkner, R. L. Dunsmore, S. Ball, H. W. Mahon, H. S. Johnston, C. Scrymgeour.

PETURSSON—FRANKLIN, of Kenora, Ont., Born at Foam Lake, Sask., April 16th, 1906; Educ., B.Sc. (C.E.), Univ. of Man. (Thesis to write for M.Sc. degree); 1927 (summer), concrete inspr., Over & Munn, Winnipeg; 1928 (summer), concrete inspr. for C.N.R. water supply, western provinces; 1928-29, demonstrator in engrg. dept., Univ. of Man.; 1929-30, instr'man on location and constrn., C.N.R., western provinces; With Dept. of Northern Development, Kenora District, as follows: 1930-31, engr. in charge of location party, Trans-Canada highway; 1931-34, res. and divn. engr. on constrn.; 1934 (5 mos.), res. engr. in charge contract work; 1934-35 (5 mos.), divn. engr. in charge of contract work; Jan. 1935 to date, location engr. (*St. 1928.*)
References: J. N. Finlayson, G. H. Herriot, T. C. Main, R. R. Moffatt, A. E. MacDonald.

RONEY—GERALD VAN LUVEN, of Montreal, Que., Born at Kingston, Ont., Sept. 4th, 1903; Educ., B.Sc., Queen's Univ., 1926; 1921-25 (summers), chainman, rodman and instr'man., engrg. service, Canadian National Parks, Banff; 1926 (summer), struct'l. detailer, Canadian Bridge Co., Walkerville, Ont.; 1926-27, senior dftsman., Pennsylvania State Highway Dept.; 1927 (May-Oct.), struct'l. detailer, Pittsburgh-DesMoines Steel Co., Pittsburgh; 1927-28, checker and later squad boss, F. L. Hughes & Co., Rochester, N.Y.; 1928-29, designing dftsman., on struct'l. design, Chesapeake and Ohio Rly. Co., Richmond, Va.; 1929-32, checker on struct'l details, Manitoba Bridge and Iron Works. Transferred to Dominion Bridge Co., Winnipeg, in same capacity, when these firms amalgamated; 1934 (Apr.-June), dftsman. on design drawings of new unit, McColl Frontenac Oil Co., Montreal; Since June 1934 in full charge of engrg. dept., and at present chief engr., Farand & Delorme Ltd., steel fabricators, Montreal, Que. (*St. 1925.*)
References: J. M. Wardle, W. P. Wilgar, M. S. Nelson, B. R. Perry, W. L. Malcolm.

SMITH—CARL CLIFFORD, of 187 Sanford Ave. No., Hamilton, Ont., Born at Madoc, Ont., June 25th, 1907; Educ., B.Sc., Queen's Univ., 1932; 1929-30 (summers), tests and transformer design, Candn. Crocker Wheeler Co.; With Canadian Westinghouse Company, Hamilton, as follows: 1932-33, engr. ap'tce course, dfting., induction motor dept., and tests; 1933-34, power house installn., in charge of welding; June 1934 to date, induction motor design. (*St. 1928.*)
References: H. U. Hart, W. F McLaren, D. W. Callander, D. M. Jemmett, L. T. Rutledge.

SMITH—WALTER ALEXANDER, of 222-3rd Ave. N.E., Calgary, Alta., Born at Belfast, Ireland, June 30th, 1909; Educ., B.Sc. (Civil), Univ. of Alta., 1933; 1929-32 (summers), and 1933 (7 mos.), dftsman., Industrial Securities Ltd., Calgary, rodman, city engr's office, Calgary, rodman, C.N.R. constrn., rodman, National Parks of Canada, Big Bend Highway; 1934 (6 mos.), instr'man., National Parks of Canada, on constrn. Lake Louise-Jasper Highway; Since Dec. 1934 employed as labourer with Dominion Bridge Company, Calgary. (*St. 1932.*)
References: J. R. Wood, R. S. L. Wilson, H. R. Webb, J. Dow.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

CITY ENGINEER

A. H. Evans, clerk, will receive applications for the position of City Engineer, city of Port Arthur, up to 5 p.m. Thursday, March 21st, 1935. Applications to state qualifications, experience, etc. and to be in sealed envelopes marked "Application for position of City Engineer."

ELECTRICAL DESIGNER, experienced in the design of single phase fractional horsepower motors. Also capable of taking charge of motor department. Location western Ontario. Apply to Box No. 1114-V.

Situations Wanted

ESTABLISHED SALES ENGINEER. Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, Canadian, with technica training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-clectric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the eale of heavy machinery. Apply to Box No. 142-W.

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.Ec., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., Jun. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten yeare includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

Situations Wanted

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Ec., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters of Branch secretaries.

CHEMICAL ENGINEER, E.E.I.C., B.Ec., University of Alberta, '30. Age 31. Single. Six seasons practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box. No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W

ELECTRICAL ENGINEER, B.Ec. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. **Location immaterial.** Apply to Box. No. 651-W.

Situations Wanted

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experiences includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Ec., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Ec., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), E.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No. 729-W.

MECHANICAL ENGINEER, E.E.I.C., B.A.Ec., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location **immaterial.** Apply to Box No. 740-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.Sc., A M.E.I.C., with fifteen years experience mostly in pulp and paper millwork, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

BRIDGE AND STRUCTURAL ENGINEER. A.M.E.I.C., McGill. Twenty-five years experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

Situations Wanted

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

Situations Wanted

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Volume XVIII — Montreal, April, 1935 — Number 4

The Water Supply of the Prairie Provinces

Leading points in the papers presented at the Annual Meeting in Toronto on February 8th, 1935, with notes on the discussions which followed.

In dealing with the subject of precipitation, *Mr. John Patterson's*[1] paper points out that the rainfall over a continental area like the prairie provinces is not determined by local conditions, but by world-wide forces causing the movement of great masses of polar and tropical air; thus its amount and general distribution cannot be altered by human effort.

In reference to the matter of surface water supply and run-off the paper by *Mr. J. T. Johnston*[2] gives statistics indicating the severity of the present drought, since the run-off from prairie sources during the past six years has been only 20 to 30 per cent of the twenty-year mean. The run-off from mountain sources has been better maintained, but has nevertheless shown a marked decrease.

The availability of ground water depends largely on its distribution and *Mr. R. T. D. Wickenden's*[3] contribution indicates that the bedrock formations of West and South Saskatchewan are capable of yielding considerable supplies which, however, have to be pumped. There are also artesian areas which are not yet completely known, and require further investigation as to their extent and yield, before proper conservation methods can be developed.

Ground waters in the prairie provinces are especially liable to mineralization, and the paper by *Mr. D. C. Maddox*[4] states that while artesian waters are generally potable, they often contain a fairly high proportion of soluble salts. The waters from the shallow wells in surface deposits or glacial drift vary greatly in mineral content, but as a rule contain smaller amounts of soluble salts, and are the most satisfactory for drinking purposes. Investigation is desirable as to the possible improvement of the artesian waters by mixture or possibly by chemical treatment.

Mr. W. Calder[5] in his paper dealing with well drilling in Alberta draws attention to the importance of controlling rural well sinking so as to avoid the pollution or mineralization of otherwise potable supplies.

Messrs. W. A. Johnston and R. T. D. Wickenden[6] consider that soil drifting is largely the result of dry-farming methods and single crop farming, combined with the general absence of wind breaks. The character, extent and mode of origin of soils in Manitoba and Saskatchewan south of 52 degrees are discussed in relation to soil drifting, and references are given to the valuable information on this subject contained in the soil survey publications of the University of Saskatchewan.

As a result of his long experience, *Mr. N. M. Ross*[7] believes that there is little basis for the claim that tree planting changes the climate of a large area, or will increase the rainfall. The local benefits to be derived from shelter belts and tree planting are, however, quite definite. To grow trees successfully in the prairies requires considerable care, cultivation and the proper choice of varieties. Trees *can* be grown where there is sufficient moisture for wheat, but successful results will not be obtained without proper attention. They should be planted at the commencement of a period of normal precipitation, not during severe drought. Great assistance has been given in this matter by the Dominion Forest Nurseries Station, which has distributed nearly one hundred and forty million seedlings to more than fifty thousand farmers.

The paper by *Mr. P. C. Perry*[8] gives the results of his study of drainage basins in southern Alberta, Saskatchewan and Manitoba. He points out that in the prairie generally the annual evaporation from open water is about twice the precipitation, and that the final run-off of prairie streams does not exceed about two per cent of the precipitation. He is of the opinion that the theory of regular climatic cycles due to sun spots, etc., has little weight. He advocates the construction of storage reservoirs wherever possible, varying in size from small dugouts for individual farms to large lakes. He also points out that in the utilization of available water supplies, problems of administration are likely to arise.

In his general study of water conservation *Mr. T. C. Main*[9] draws attention to the waste of surface water which has occurred in the past. He believes that there has been a steady, though small, rise, say about 2 to 4 degrees, in the average temperature in the prairie regions for the past sixty years, although it appears that the trend is now reversed. He emphasizes the importance of adequate water supply in maintaining a proper standard of living, and holds that the water available should not be used for wheat

1 Precipitation in the Prairie Provinces. See page 176.
2 Surface Water Supply and Runoff of the Prairie Provinces. See page 181.
3 Some Possible Sources of Ground Water in Southern Saskatchewan. See page 193.
4 Mineral Character of the Underground Water in Southern Saskatchewan. See page 196.
5 Rural Water Supply in Alberta. See page 198.
6 Relationship of Geology to Soil Drifting in Southern Manitoba and Southern Saskatchewan. See page 200.
7 Tree Planting in Relation to Drought Control. See page 202.
8 The Surface Waters of the Canadian Prairies. See page 204.
9 Water Conservation in the Prairie Provinces. See page 212.

irrigation but for individual farm supply. As regards major schemes for water conservation, he refers to proposals which have been made for dealing with the South Saskatchewan river, the Frenchman river in southwestern Saskatchewan, Swift Current creek, the Qu'Appelle river at Buffalo Pound Lake, and the Souris river in southeastern Saskatchewan, together with projects for preserving and enlarging various lakes such as Big Muddy Lake, Willow Bunch Lake and Goose Lake. He points out that these and other similar schemes have not yet been studied in detail as engineering projects. Such study is necessary before opinions can be expressed as to their economic feasibility.

The paper by *Mr. Walter Blue*[10] gives some results of his preliminary study of the possibility of damming the South Saskatchewan river near the Elbow. This glacier-fed river is the principal large-scale source of possible supply in the drought region, and could probably furnish over two million acre-feet annually. Construction work would have to be on a large scale and would be costly, as the maximum discharge of the river is some 130,000 second feet. The development would make power available for pumping, and in his opinion, the scheme deserves a complete engineering study.

In regard to conditions in the United States, the memorandum by *Mr. L. A. Jones*[11] supplies information on the Federal Emergency Relief Administration activities in the drought areas of North Dakota and Montana during the year 1934-1935. The large sums made available by the F.E.R.A. have been devoted largely to direct relief and the provision of food, fodder for livestock, and seed for farms, but have also provided for considerable expenditure on tree planting, the development of water supply improvements and irrigation systems, and the construction of small reservoirs. Ground and surface water surveys have been made and work has been provided for a large number of men who were on the relief rolls. The assistance thus afforded has enabled many farmers to remain on the land who would otherwise have been forced to leave it.

* * *

In the discussion based on these papers much additional information was given. The following notes refer to written discussions received, as well as to those presented orally at the meeting.

These discussions are printed on pages 221 to 231 inclusive, of this issue.

Mr. H. G. Cochrane pointed out that the drought problem resolved itself into the question of how to make the prairie area more habitable. A great deal of information is already available, and more should be secured, as a basis for systematic investigation, for which funds might be supplied partly by investors interested in the area, such as railways, insurance companies, manufacturers and so on. He would suggest the formation of a committee to approach such bodies for contributions, to undertake the study required and to report to the contributors and to the various provincial governments concerned.

Mr. C. H. Fox agreed that the majority of proposals for engineering works so far made had been insufficiently studied technically, for example, the proposed Riverhurst diversion of the South Saskatchewan river for the purpose of distributing water over 8,500 square miles. This would involve a dam 2,000 feet long, 200 miles of distributing channel or pipe and 80,000 h.p. for pumping. He would prefer to consider a less ambitious scheme such as that suggested by Mr. Blue. He was heartily in favour of minor engineering works for the control of drainage, flood and run-off water, and also the provision of shelter belts for the benefit of the individual farmer.

Mr. Perry considered that Mr. Main's condemnation of drainage was too sweeping, and he was unable to support Mr. Main's theory of the effect of ratio of water to land area on climate. He did not think this was tenable except in regard to continental masses and oceans. He drew attention to the changes which had occurred in the areas of sloughs and lakes, as for example a lake near Lampson, which in 1927 covered 3,000 acres. This area was dry in 1912, partly filled in 1916, dry again in 1922, completely filled in 1927, and is now dry and has been dry since 1930. These changes took place irrespective of drainage ditches or any artificial factor, and he did not think the drainage measures taken over most of the prairie areas had had any appreciable effect on climate. He was strongly in favour of water conservation by means of farm ponds and small reservoirs on local streams, but thought that the larger schemes, such as that proposed for Buffalo Pound Lake, for the Souris river, and for the South Saskatchewan, should certainly be deferred.

Mr. Attwood summarized the views of Premier Bracken as expressed in the speech delivered on October 25th, 1934, at Winnipeg. This admirable presentation of the rehabilitation problem described the situation and pointed out that immediate action is necessary if we are not to witness similar distress at recurring periods in the future. The Premier of Manitoba had remarked that in approaching such a problem the basic facts must first be discovered, and that reforestation, power, drainage practice, soil management and cropping methods must all be taken into consideration. A reclamation programme should provide for a thorough survey of the area affected and should result in specific recommendations regarding agricultural production and conservation plans for each separate soil zone.

Mr. Patterson, supplementing the information given in his paper, stated that conservation methods could not affect the climate of the region as a whole. He believed that the slow increase in temperature observed in Manitoba was not confined to the prairies but was possibly world wide.

Mr. Main drew attention to the various meanings assigned to the term "climate" but thought that it would be useful to follow Geiger in distinguishing between macroclimate and microclimate. The former term referred to the general climate of a whole area, and the latter to the climate close to the ground or in small areas as affected locally by the presence of ponds, shelter belts and the like. Microclimate is therefore amenable to human control to a certain extent.

Mr. F. K. Beach was doubtful whether there really had been the 20 per cent increase of evaporation of which Mr. Main had spoken, and whether there was a real cyclical variation of run-off due to sun spots or other causes. He desired to point out that Mr. Main's proposal to furnish water to individual farmers in amounts sufficient to supply 15 acres per quarter-section would involve immense expenditure, and judging from past experience this would all have to come from the public purse. He believed that the most pressing immediate needs were the withdrawal of unsuitable land from cultivation, the provision of dams and reservoirs, and the control of well digging and the use of ground water.

Mr. F. W. Caldwell drew attention to the work of the various state planning boards in the United States. These now exist in forty-one states, and there are, in addition, two regional planning boards. Their function is to plan for the utilization of the natural resources of the state or region regarded as an economic whole, and he would suggest the desirability of similar measures as regards Canada's arid regions.

10 Storage on the South Saskatchewan River. See page 218.

11 Water Phases of the Drought Relief Programme of the United States Federal Emergency Relief Administration. See page 220.

Professor Chandler, as a result of thirty-two years' experience of run-off conditions in North Dakota, had obtained figures which agreed substantially with Mr. Perry's. In prairie land run-off does not form any definite proportion of the precipitation but consists mainly of water which runs away after sudden storms before it has had time to sink in, or of spring flow-off resulting from rapid melting of snow when the ground below is still frost-bound; This is available in the spring, and its amount varies greatly in different years. The storage of such waters is one of the most important items in a water conservation programme.

Mr. J. W. D. Farrell was in agreement with Mr. Main in considering that the feature of primary importance is not irrigation but the provision of the necessary supply on the farms for human and animal use. He doubted whether many local reservoirs would survive prolonged drought, although they would undoubtedly better conditions in the intervening periods. He cited the case of Wascana Lake at Regina, which covers an area of 200 acres and was full up to the spillway in 1928, was nearly empty in 1931 and in 1934 was full again.

Mr. D. A. R. McCannel pointed out that the time of the year at which precipitation occurs is as important as the amount which falls. Frequent moderate rainfall during the growing season, June and July, is the most beneficial. He considered that in the construction of small and medium sized reservoirs or dams, engineering advice is essential, and works of this character are the first necessity. The economic feasibility of large and expensive schemes should be thoroughly investigated before they are embarked upon.

Mr. C. J. McGavin quoted various divergent opinions on the effect of forests on climate. The annual rings in trees laid bare by the recession of lakes in North Dakota indicated that wet cycles have come and gone for over one hundred years. He considered that the shape of a drainage basin, whether long and narrow or round, had marked effect on the amount of run-off and the intensity of floods originating in that drainage area. Mr. McGavin was unable to follow Mr. Main in tracing a relation between run-off and sun spot cycles. He thought that a ten-year period was generally considered sufficient for hydrometric records except in the case of the design of major structures, where longer records, say fifty to sixty years, were almost essential. Mr. McGavin suggested a formula for mean temperature taking care of longitude, latitude and altitude. He agreed that the primary need is for dams for domestic and stock watering, and believed that an inventory should be taken of the water resources of each township, together with considerable further investigation of the ground water resources of the dry areas.

Dean C. J. Mackenzie considered that there are two schools of thought: one holding that climatic conditions can be affected to some degree by man's efforts, and that precipitation may be increased by tree planting and the creation of reservoirs, also that large-scale projects such as Mr. Main outlined in his paper are desirable and practicable. The other school believes that such measures are impracticable, that the remedy lies rather in the field of improvement of agricultural and tillage methods for the purpose of reducing evaporation and lessening soil drifting, and that a reorganization of our social and political institutions, perhaps in the form of an insurance scheme for relief purposes, is more practical and economically justifiable, for the purpose of tiding over the periods of drought which will inevitably return. He favoured this view.

Dean Mackenzie felt that Mr. Main's scheme of bringing water to individual farms by pipes is a bold conception, but on investigation would be found impracticable under present economic conditions. He considered that the most promising course would be a system of planning and insurance which would cover all areas against drought, and agreed with Mr. Main that there is urgent need of a commission of enquiry of a broad nature to bring together the opinions of meteorologists, agriculturists, engineers and statesmen.

Mr. R. W. McKinnon was of the opinion that while tree belts would have no appreciable effect on the amount of precipitation, they would be helpful as regards soil drifting. The present, however, is not the time to start tree planting on a large scale, by reason of the deficiency of ground water. In all forestation or tree planting schemes the individual co-operation of the farmers is essential, and this is also the case in regard to the formation of ponds and dams, which in dry years he felt would be in danger of filling with drift soil if unprotected. He was of the opinion that there are still places where drainage and reclamation is desirable, and did not think that drainage due to the efforts of farmers and highway constructors and the railways had had the prejudicial effect which some speakers had mentioned.

Mr. Perry remarked that as regards the construction of dams and reservoirs, something had already been accomplished. Last year nine municipal reservoirs had been built in Saskatchewan under proper engineering supervision, while about forty others were now contemplated. He drew attention to the successful establishment of reservoirs by the railways. Mineralization of reservoir waters had not been found serious by the railways. He believed that large scale irrigation is not a paying proposition on the Canadian prairie. Mr. Perry disagreed with Mr. McGavin as to the effect of tree planting, and considered that the chief use of shelter belts would be to concentrate water in desirable spots and help to supply and protect reservoirs and reduce evaporation from them.

Mr. L. P. Rundle suggested the formation of a commission by the Federal government which would be in touch with an engineering representative of each province. The ideas and methods of rehabilitation work in the United States should be studied. Meteorological data should be secured and recorded by an international meteorological clearing house for the North American countries. The government commission should study individual areas as to their fitness for agriculture, grazing and tree planting. There should be proper regulation of drainage, uniform legislation as to water rights, and the various legislatures and the public should be informed by the commission as to desirable conservation schemes. The commission would also make recommendations as to finances.

Mr. R. S. Stockton, in an address made before the Calgary Branch of The Institute, had drawn attention to the way in which the fertility of large areas in the prairie provinces had been destroyed, and remarked that the principal remedies available appear to be strip farming, seeding of considerable areas to grass or other selected suitable plants, the employment of live stock so that manure would be available, the diversion of perennial streams for irrigation where possible, the conservation of run-off water, the provision of shelter belts, and the adjustment of land taxation. Much of the work involved would need engineering supervision, as for example the construction of dugouts and dams for the storage of storm water in farms and the control of well digging and pumping to ensure proper utilization of available ground water resources.

Precipitation in the Prairie Provinces

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

A symposium on the water resources in the prairie provinces necessarily involves the question of rainfall in these provinces or on the drainage basin of which they form a part. Meteorologically the two factors to be considered are evaporation and rainfall, but the disposal of the rainfall after it reaches the earth must be dealt with by those who have made a special study of the problems. This paper will be confined entirely to the question of precipitation, evaporation and temperature in the prairie provinces.

There are many erroneous ideas prevalent in regard to precipitation as it may be affected by opening the country up for settlement. The ideas seem to change according as the rainfall is abundant over a period of years, or the opposite. In the period of abundant rainfall there was a prevalent idea that the opening of the country up to agriculture increased the rainfall; now the pendulum has swung violently in the opposite direction, and many people believe that the cultivation of the land and the drainage of sloughs, ponds, lakes, etc., has decreased the rainfall, and has been a very important factor in producing the drought that has prevailed for the last number of years.

It would be well therefore to consider first of all the actual physical processes that are in operation to produce precipitation. The first question naturally is whether the processes that produce precipitation are entirely local in their origin or world wide. If the former, then we would naturally expect that decreased evaporation and decreasing water areas might have an appreciable effect on the precipitation. On the other hand, if the processes are the result of the operation of world wide forces then the local conditions would play, at the very most, a very insignificant part. The fundamental facts are as follows:

The air receives its supply of water vapour by evaporation from all water surfaces, and from moisture in the surface soil, and from transpiration from vegetation. Naturally the greatest source of moisture is the tropical regions where there are enormous water areas and high temperature. On the other hand, the lowest evaporation occurs in deserts and in the arctic regions where it is very cold and largely continental. There is thus passing into the air an enormous quantity of moisture from evaporation, and this moisture is distributed by the air currents over the face of the earth, but after getting the moisture into the air the next question is "how is the moisture to be taken out." This is probably the factor which leads to erroneous conceptions about the effect which evaporation has on rainfall in a region. Apparently many believe the only question is that of getting the moisture into the air, completely forgetting the means by which it can be taken out, and the incomprehensible amount of energy required to carry through the weather processes.

In connection with getting the moisture out of the air, it is necessary first to consider the physical facts about the atmosphere on which these processes are based. They are:

(1) The higher the temperature the more moisture the air can contain.

(2) There is a definite amount of moisture that can exist in the form of vapour for any given temperature. Experiments show that at a temperature of 32 degrees F. the air can hold about 22,000; at 70 degrees F. 85,000; and at 100 degrees F. 210,000 tons of water per cubic mile, in the form of vapour.

(3) The temperature decreases with height above the earth's surface. Experiments show that on the average the temperature decreases about 3½ degrees per thousand feet of elevation.

These are the physical conditions in the atmosphere on which the weather processes operate in order to get the moisture out of the air. There is always a certain amount of moisture in the atmosphere, and from what has just been said if the air can be cooled sufficiently the temperature will be reduced below the saturation point and thus the excess moisture will be condensed into fog, cloud, or precipitation. If much rain is to be obtained the air must be cooled on an enormous scale, as the only amount of moisture that can be taken out is that between the saturation point and the final temperature to which the air is reduced; thus if the air saturated at 70 degrees F. could be reduced to 60 degrees F. there would only be 24,000 tons of water per cubic mile of atmosphere taken out, and that would give about one-third inch rainfall per square mile. This is a very extreme case, but it gives one some conception of the enormous supply of vapour that is necessary in order to produce rainfall on an extensive scale.

The only method in nature whereby this cooling can be produced on a scale sufficiently great to produce extensive precipitation is to force the air to rise in the atmosphere,

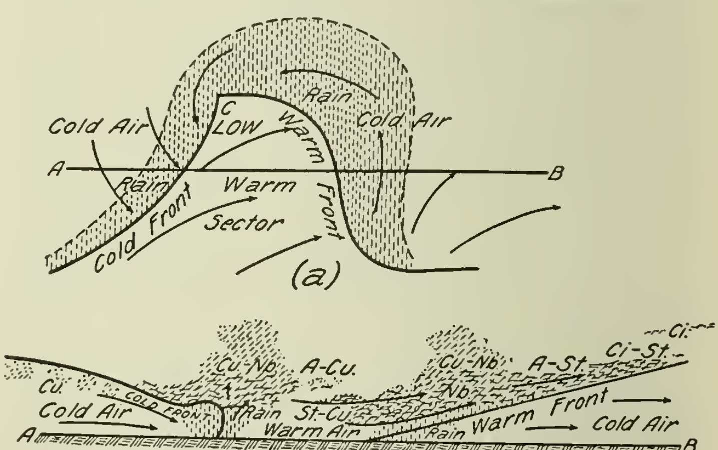

Fig. 1—Horizontal and Vertical Section of an "Idealized Cyclone."

thus cooling it at the rate of about 3½ degrees per thousand feet of elevation; at the same time a continuous supply of moist air has to be provided. How can this air be forced to rise? One of the familiar means by which forced ascension can take place is that of moisture-laden winds blowing up against the side of a mountain. Here the mountain compels the air to rise and thereby cools it, so that the moisture is precipitated, but away from the mountain we must have something in the atmosphere itself that will take the place of the mountain. This has been the subject of long investigation, especially of the conditions existing in the upper atmosphere, and as a result we now know that there exist in the temperate regions at any rate two great air masses or air currents. They are known as "the polar current" or polar air mass, and "the tropical current" or tropical air mass. Their names give some idea of their characteristics, that is, the polar current is cold and comparatively dry, as it originates in the polar regions; the tropical current, coming from the tropics, is warm and generally moist.

While these are the distinguishing features of the two air masses, yet each may be sub-divided into a great many different types, according to their origin over land or over water, and their subsequent history; if over land, they would naturally be dry whether tropical or polar; if over the water they would contain a considerable amount of water vapour depending of course on the temperature. These currents can preserve their identity for a long time, being gradually modified of course by the region over which they are passing. Probably their most striking feature is that they can exist side by side for great distances without any appreciable mixing.

The operation can be explained most easily by means of a diagram of what we may call "the idealized cyclone." The tropical current, by some means which is not yet understood, forces its way into the polar air current, and once this action is set up it goes on to completion.

As the cyclone or low pressure area develops we find the condition illustrated in Fig. 1. Here the tropical air current on one side drives into the polar current and the line of intersection is known as "the warm front" since it is the warm front that is advancing against the cold. On the other side of the tropical current the polar air mass is advancing against the tropical and this is known as "the polar front" or cold front. Some idea of the extent of this area may be gained from the knowledge that the distance from the front to the rear of the idealized cyclone as measured along the line A-B may exceed 1,000 miles.

In Fig. 1 the tropical current drives back the polar air current along the warm front. At the same time it runs up over the cold current which may be likened to an enormous wedge with a slope of about 1 to 200 and impenetrable to the warm current so that the warm current is forced to flow up along this wedge. It is easily seen what happens as the current advances farther and farther up the slope. The warm current is lifted higher and higher until first there is cloud, then higher still, rain. After the rain has been taken out we get the higher cloud, the alto, and higher still the cirrus, thin wispy clouds which are often seen spreading across the sky, the harbinger of an approaching disturbance.

It is thus not a case of simply lifting up the air over the place of observation, to the region where it can be condensed into cloud or rain, but the flowing of a continuous supply of warm moist air up this slope, so that the abundance of rainfall in the region will depend on the amount of moisture in the air and the degree of cooling to which it is subjected. This will determine whether it is mere drizzle, moderate rain, or heavy rain, while the duration of the rainfall will depend on the rate at which the polar air current is driven back.

Thus it will be seen that in such cases the surface air over the region where rain is falling is acting as the wedge up over which the warm moisture laden currents are flowing and consequently no rain can be obtained out of the surface air and thus evaporation at the place plays no part in the rainfall over the region.

As we pass back along the line B-A into the tropical current we come into higher temperature, high humidity, and a region usually very muggy and oppressive, even more so than when it was raining in the warm front region. There is no precipitation, probably no cloud, because in this region there is nothing that will force the ascension whereby the air mass may be cooled.

As we pass farther westward towards A we come to the cold advancing front which impinges against the warm current and undercuts it, forcing the warm current up to enormous heights and causing tremendous turbulence in the atmosphere. It is generally along this line that we have

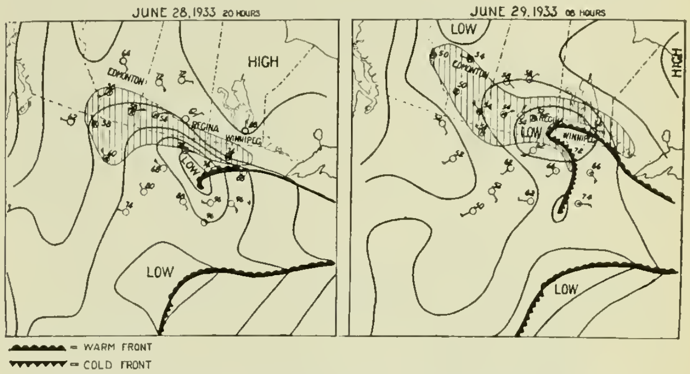

Fig. 2—Weather map for June 28th and 29th, 1933.

showers, violent thunderstorms, hailstorms and violent line squalls.

This front of advancing cold air has a slope of about 1 in 100 with a sort of round nose, as indicated in the diagram. The strip is comparatively narrow, and as it sweeps by, we emerge into clear polar air.

As the cold advancing front arrives suddenly and undercuts the warm tropical current it might appear as if here is a place where evaporation over lakes, ponds, sloughs and from the ground generally, would play an important part in the amount of precipitation received. In this connection it must be remembered that there is always a certain amount of wind, especially in the higher levels, and the moisture is thus carried away as rapidly as it is evaporated, probably travelling over 200 miles in the course of a single day. If it could possibly be imagined that the air remained perfectly calm for a space of say six hours, before the advent of the cold front, it would be found that the greatest amount of evaporation that could occur in that time would be about .06 of an inch from a free water surface, and very much less from comparatively dry land. Consequently, even admitting that this evaporation was returned as rainfall to the surface, the amount would be infinitesimal, in fact it is so small that it would be evaporated while falling through the air. This however, is not what happens. There are as already stated two great air currents, one the polar and the other the tropical. Along the line of the polar front, we have the meeting of two strong opposite currents, each of them converging along a common line, and it is this piling up of the air from both directions along the junction that causes such a tremendous turbulence in the atmosphere, giving the heavy thunderstorms, etc., that are often experienced. Thus even in this particular case, one can see that evaporation over a region plays no part whatever in the amount of precipitation that may be received.

That this idealized cyclone which has just been described represents what is actually taking place in the atmosphere when the weather systems are well developed is illustrated in Fig. 2, which shows the actual meteorological conditions existing on June 28th and 29th, 1933, in the prairie provinces. During the summer months there is what is called a "quasi stationary front" which extends practically across the continent, a portion of it being shown in Fig. 2, at the bottom of the diagram. This front moves from north to south in the eastern part but there is very little motion in the western part especially near the mountains. There is in addition to that in the summer time another frontal system which moves down from the north and ultimately joins up with it. In the particular cases here given on the 28th of June this second or northern front is shown in Dakota, the warm front being specially well

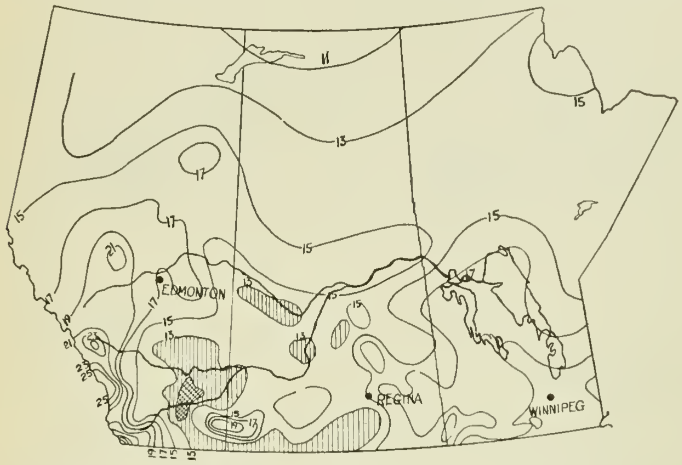

Fig. 3—Average Annual Total Precipitation in Inches.

developed. Here the warm air from the south is over-running the cold, so much so that it has given rain over the hatched area. This is typical of what is shown in the northern part of the idealized cyclone. Notice that the temperature in the rainfall area or in the cold air mass is comparatively low, whereas in the region to the south of the warm front it is high. To the north of the front the winds are east, north-east or north, while those to the south are generally southerly in direction.

On this particular day the cold front was not definitely marked, but it developed during the next twelve hours so that the weather map of June 29th looks very much like the diagram for the idealized cyclone. Here again there is a tremendous over-running of warm air over the cold, so that precipitation has actually extended as far north as Edmonton and Jasper. There is also well marked rain to the east of the warm front, but most of it is to the north and west. The wind system is again much the same, and the usual marked difference of temperature between the cold and the warm air masses. The cold air mass contributes practically no moisture to the general precipitation, as it forms the wedge over which the warm and moist air current from the south is running. In this particular storm there was very general and heavy rain generally without thunderstorms over all the region represented by the hatched area. It must be remembered however that in all systems there is every gradation from those that are well marked in this example to others where it is with great difficulty that any distinction can be made between the air masses. Moreover, much of the rainfall received in the prairies is of the cold front type instead of the warm front as illustrated and consequently comes more frequently in sudden showers than in any other way. These showers are often very local; just what sets up the mechanism in the cold front region, thus starting the process in many different places, it is difficult to say. There are probably local topographical features involved, and it is usually in the place where there is greatest instability in the atmosphere causing a greater uprising of the air currents when the cold front arrives. Of course, hills of a moderate size would be very favourable for starting these uprising currents and thus accelerating the production of the rain.

In these cases there is not a great amount of moisture available in the atmosphere, and consequently we do not get rain on a very extensive scale. It must be remembered that the extent of the rainfall depends on the amount of moisture in the tropical current, and the amount of cooling to which it is subjected. In the case where there are just local showers it is probable that the convective action has been carried far enough to produce the shower, while in other places it has not been carried sufficiently far to produce rain.

It may be noted further that the prairie area forms one of the most interesting regions meteorologically that there is for the study of weather processes. Mountains to the west impose such a great barrier on the advancing fronts that they are broken up at the surface as they hit the mountains and are apparently carried across high up in the atmosphere, and thus do not show themselves at the earth's surface until they have advanced some considerable distance from the mountains. This is a subject which it is hoped to investigate very specially as soon as the necessary means are available for that purpose.

The foregoing is an attempt to explain the process by which precipitation on an extensive scale is produced. Unless these two great air currents meet over the region, it is utterly impossible to get rainfall of any account, that is, there will not be rainfall of any appreciable amount in a region which is entirely under the influence of either the tropical or polar current. Thus when drought conditions appear, either one or other of these currents is very weak, and generally this is the polar current, so that the prairies are largely under the domination of the tropical or warm air current during years of drought; this being the case, there is usually more moisture in the air per cubic foot than there is in years of good rainfall, but as there is no means by which the ascension of the air can be forced, there is in consequence no precipitation. This also explains why as you go north in the prairies, rainfall becomes more certain and droughts much less frequent. It is the region where the tropical and polar air currents meet more frequently.

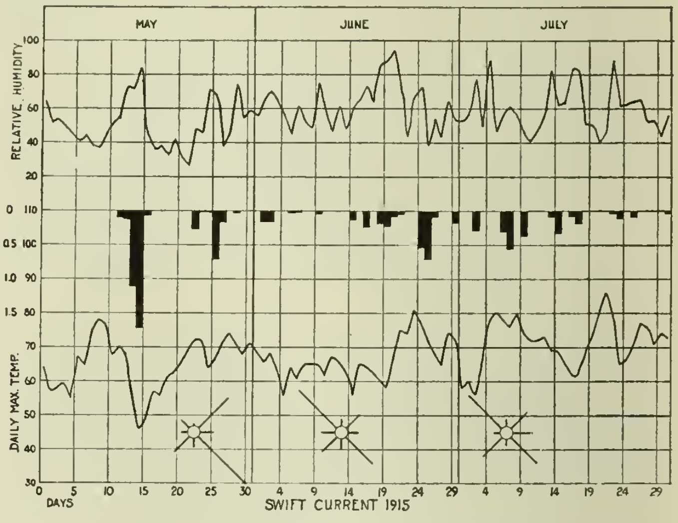

Fig. 4—Daily Rainfall, Maximum Temperature, Relative Humidity, and Prevailing Wind Direction.

Having discussed the cause of precipitation and the general world meteorological conditions that exist during years of drought and years of good rainfall, the actual weather conditions over the prairie provinces will now be considered very briefly.

In Fig. 3 the average annual precipitation in inches is shown, by lines for every 2 inches of rainfall. The hatched area represents the region where the average fall is between 11 and 13 inches and the double hatched less than 11 inches. It is shown that precipitation varies all over the world from year to year and generally the deficiency in places where the normal rainfall is abundant would have no very serious effect but in places where it is scanty it is all the difference between years of drought and years of plenty. Thus there is the rather interesting fact that the greatest amount of precipitation recorded in one year in Toronto was two and a half times greater than the lowest. This same ratio holds for Qu'Appelle, and Swift Current,

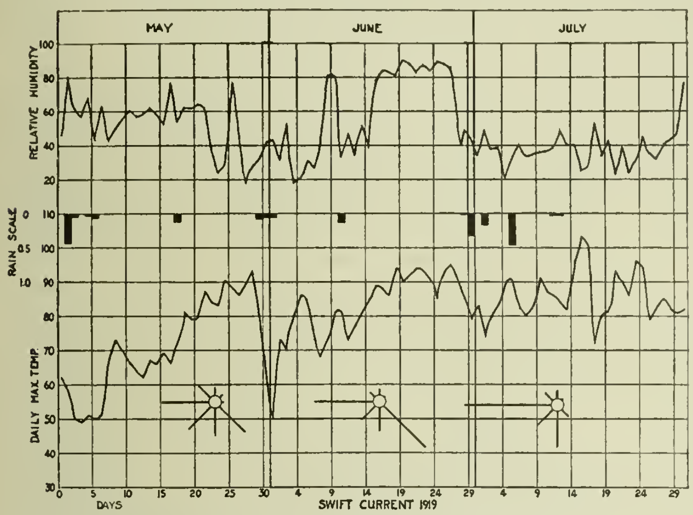

Fig. 5—Daily Rainfall, Maximum Temperature, Relative Humidity and Prevailing Wind Direction.

while at Prince Albert one was four times greater than the other. This being the common experience all over the world one must expect that in regions where normal rainfall is scanty there will be years of drought and years of plenty.

Precipitation in the prairie provinces is generally considered to be the all important meteorological factor in determining the character of the year as regards drought or plenty, but there is also to be considered its distribution in time, as well as the temperature, wind and humidity. All these are important factors in determining growing conditions.

In order to illustrate this, two years have been selected, taking Swift Current as typical of the region. One of the best years was 1915, and Fig. 4 shows day by day for the three months, May, June and July, the rainfall, maximum temperature, relative humidity at the time of maximum temperature, and the direction of the wind from the different quarters. It will be noticed that the rainfall was frequent but only on one occasion was it at all heavy. Again there were no high temperatures, the thermometer only going above 80 degrees Fah. on three occasions. Probably the most surprising part of the record is that in spite of the good rainfall, the relative humidity was fairly low. This, however, is to be expected, as in this year the prairies were dominated largely by polar air masses which as already explained have usually a small moisture content. The predominating wind direction during May was southeast and during the other months northwest, the northwest winds indicating the inflow of cool air from the Arctic. Thus the rainfall was just about normal with frequent but not heavy showers throughout the growing season, and the temperature was low, thus providing ideal conditions for a good crop.

One of the worst years on record was 1919 (Fig. 5). During this year showers were very light and infrequent and only on two occasions, and these far apart, did it exceed .45 of an inch; temperatures were high, being well over 90 degrees for nearly two weeks in June. Notice however the rather surprising feature that the humidity at this period was exceedingly high, contrary to general expectations. It indicates an inflow of warm, tropical air, but as the polar current was lacking there was nothing to force the ascension and thus produce rainfall. There is a predominance especially during July of westerly winds, indicating that the air masses were coming from the Pacific, and in these Pacific air masses the humidity was quite low.

Many more examples could be given to show the difference between a good and a bad crop year, but they would have the same general characteristics as shown for the years 1915 and 1919 at Swift Current.

The characteristics then of a good year are frequent showers, low temperature, moderate to low humidity, and a prevalence of northwest winds. On the other hand, the characteristics of a drought year are infrequent showers or showers so light as to be of little use, high temperature, prevailing southwest and west winds and moderate or low humidity.

When rainfall was good it was generally felt that these conditions would continue. Now people have gone to the other extreme, and the question is being asked, are droughts owing to the cultivation of the land a permanent condition and will years of good rainfall never return. The only answer that can be given to this question is to refer to the past and see what has happened before. This is generally called the "trend of precipitation." One of the best means to show this is to take the five-year moving mean. This mean is obtained by taking five consecutive years, dividing by five, and crediting it to the middle year; then dropping the first year, adding the next in succession, dividing by five, and crediting the result to the following year. In this way a moving mean is obtained. It sums up the average rainfall for five-year periods and it thus shows the general trend of the precipitation over long periods.

This moving mean for Prince Albert, Swift Current and Qu'Appelle is shown in Fig. 6 for the period for which records are obtained, amounting to about fifty years. At Swift Current it is noticed that there is no definite trend there having been periods of good rainfall together with periods of deficient rain. On the other hand at Qu'Appelle from about 1897 until 1925 the rainfall on the whole was good apart from occasional bad years, but since that time the rainfall has been on the whole decreasing. It will also be noticed that from the beginning of the observations in the early 80's up to 1897 there was deficient rainfall.

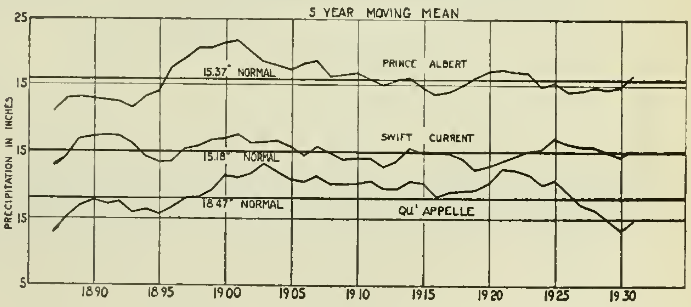

Fig. 6—Five-Year Moving Mean.

Prince Albert ever since 1905 has been characterized by rainfall not departing very much from normal.

Another method of indicating precipitation trends is that of accumulated excess or defect, that is the normal rainfall for the period is taken and beginning at the first year the deficit or excess is taken, then add the deficit or excess in the next year to the preceding and so on. In this way you build up the total accumulation or deficiency of rainfall from year to year. It must be remembered in this connection, however, that the curve must end on the normal line for the last year of the series, and thus it only indicates the trend of the rainfall.

St. Paul, Minn., which is fairly close to the Canadian border, is one station that has a long record. It extends back for nearly one hundred years. In Fig. 7 the trend is indicated in this case by a six-year moving mean and accumulated excess or defect. There was a period previous to about 1865 when it was more or less in defect, from 1865 to 1883 in excess, in defect again for a short period up to about 1893, then a fairly long period up to 1907 and since that time it has been hovering around normal.

The six-year moving mean for Qu'Appelle has been plotted on the same curve to show its similarity during the period for which there were observations from Qu'Appelle. The normal line is taken as the same in both cases, but for St. Paul the normal is 27 inches while for Qu'Appelle it is 18.6 inches. It illustrates the similarity of the trend between the two places. Considering the variation of these curves, it will be seen that they are too irregular to make any deduction from them as to the future prospects.

There has always been much discussion as to the relationship of weather to the sunspot period. There is plotted in this figure the excess or defect of rainfall for each sunspot period during the past one hundred years. The maximum is taken as the zero position and the precipitation is plotted for one, two, three, four, five and six years before and the same number of years after the maximum. It is noticed that there are about as many on one side of the normal as the other, a sort of crowding together during the periods of sunspot maximum when the deficiency or excess did not seem to be as great except in one particular year and a widening out again as the period approached the sunspot minimum. It will be seen from this that such curves could not with safety be used for any forecasting purposes, although the smoothed mean for all the curves would indicate a slight trend of rainfall in excess preceding the sunspot maximum and a deficiency for a few years following it.

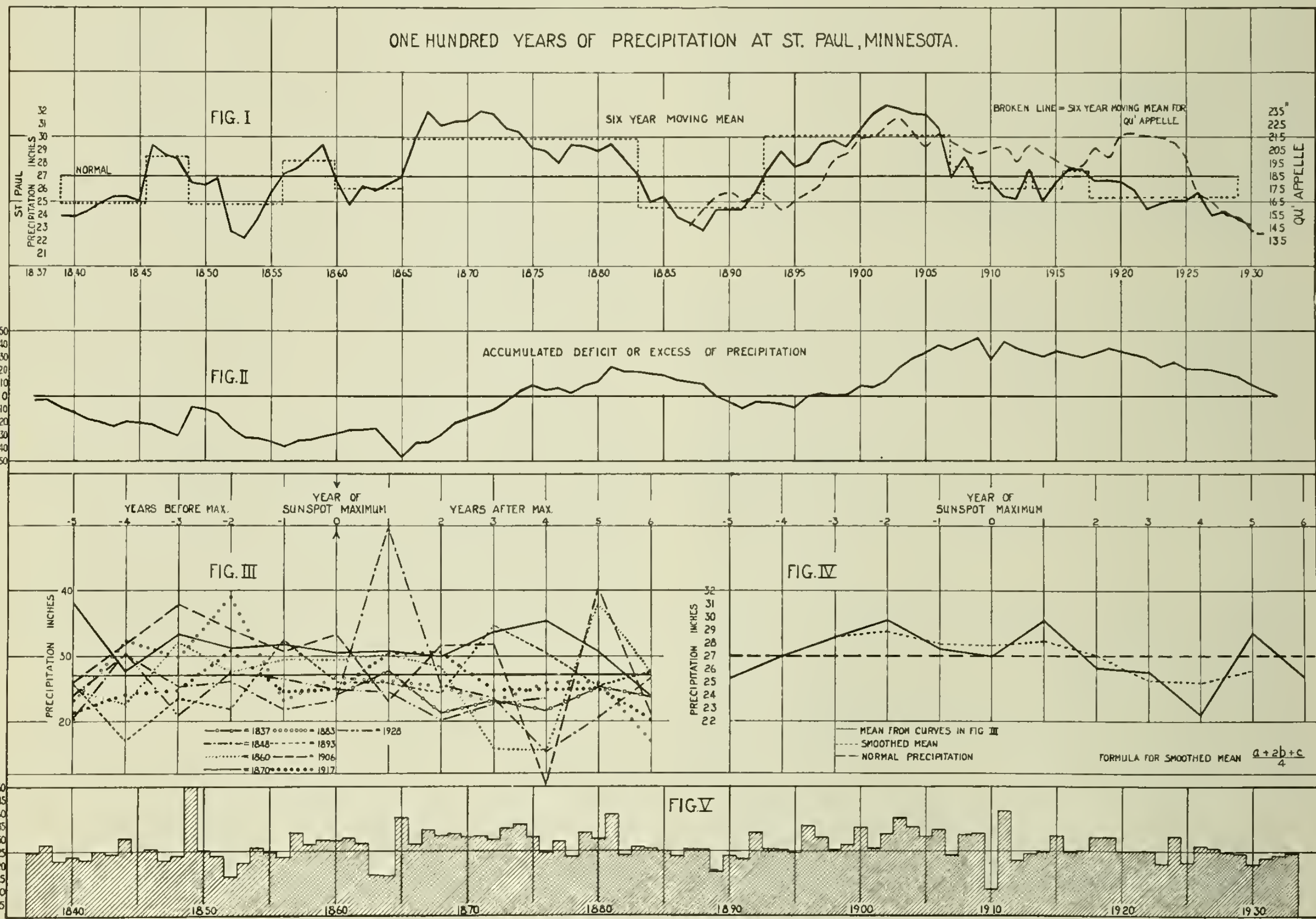

Fig. 7—One Hundred Years of Precipitation at St. Paul, Minnesota.

Surface Water Supply and Runoff of the Prairie Provinces

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SUMMARY.—This paper analyzes the records of the Dominion Hydrometric Survey as obtained by the Dominion Water Power and Hydrometric Bureau of the Department of the Interior during the past twenty years, in the southern half of the three prairie provinces. The records at eighteen typical stations have been analysed in such a manner as to distinguish between the runoff of the mountain areas, the foothill areas, the prairie and drought areas. This permits of an immediate comparison of the total supply from year to year and by cycles. The runoff from mountain sources has been fairly consistent although it has decreased somewhat during the past six years. On the other hand the runoff from prairie sources has decreased excessively during the past six years, the mean of these years being only from twenty to thirty per cent of the normal quantity, and this condition has been even more accentuated in the drought area.

The drought conditions which have obtained in the southern and central areas of the prairie provinces have concentrated attention upon the area affected and upon the various factors which have a bearing upon the situation as a whole. From the very nature of the problem the question of the water supply available, is one of paramount interest.

The purpose of this paper is to analyze the run-off conditions in the southern half of the three prairie provinces during the past twenty years. The period of twenty years is taken because hydrometric records at some of the gauging stations are incomplete before 1914. The runoff which is studied is from the two main drainage systems, the Saskatchewan river and Red river, which—except for 10,000 square miles lying along the international border and forming a part of the Mississippi Drainage Basin—drain approximately 280,000 square miles of the area extending from the Rocky Mountains to Lake Winnipeg and from the International Boundary to the 54th parallel. The attached map covers the area in question and indicates the location of the hydrometric stations, the records of which are analyzed.

Runoff records represent simply the actual runoff water which finds its way by river and stream to its ultimate goal in the ocean. In other words, it is the residual left from the sources of original supply, after losses from seepage and evaporation and from waters used in the growth of vegetation and diverted for specific purposes have been subtracted. The original sources of supply for the area in question are the ice-capped Rocky Mountains which supply a very constant and dependable runoff throughout the summer season, and the precipitation which falls in varying amounts from month to month.

It is recognized that this paper can be but a partial study of the water supply of the area in question. A complementary study of the meteorological records of rain and snowfall is necessary to properly interpret the runoff figures in relation to all sources of supply. However, the runoff records are of themselves directly indicative of water supply conditions as they obtain and as they are available for dependable utilization, and their study provides an essential background for a study of the drought conditions as a whole.

Physical Characteristics of the Prairie Provinces and of the Drought Area

As might be expected in so vast an area, the physical conditions are greatly varied and consequently exert different influences upon the runoff in different sections.

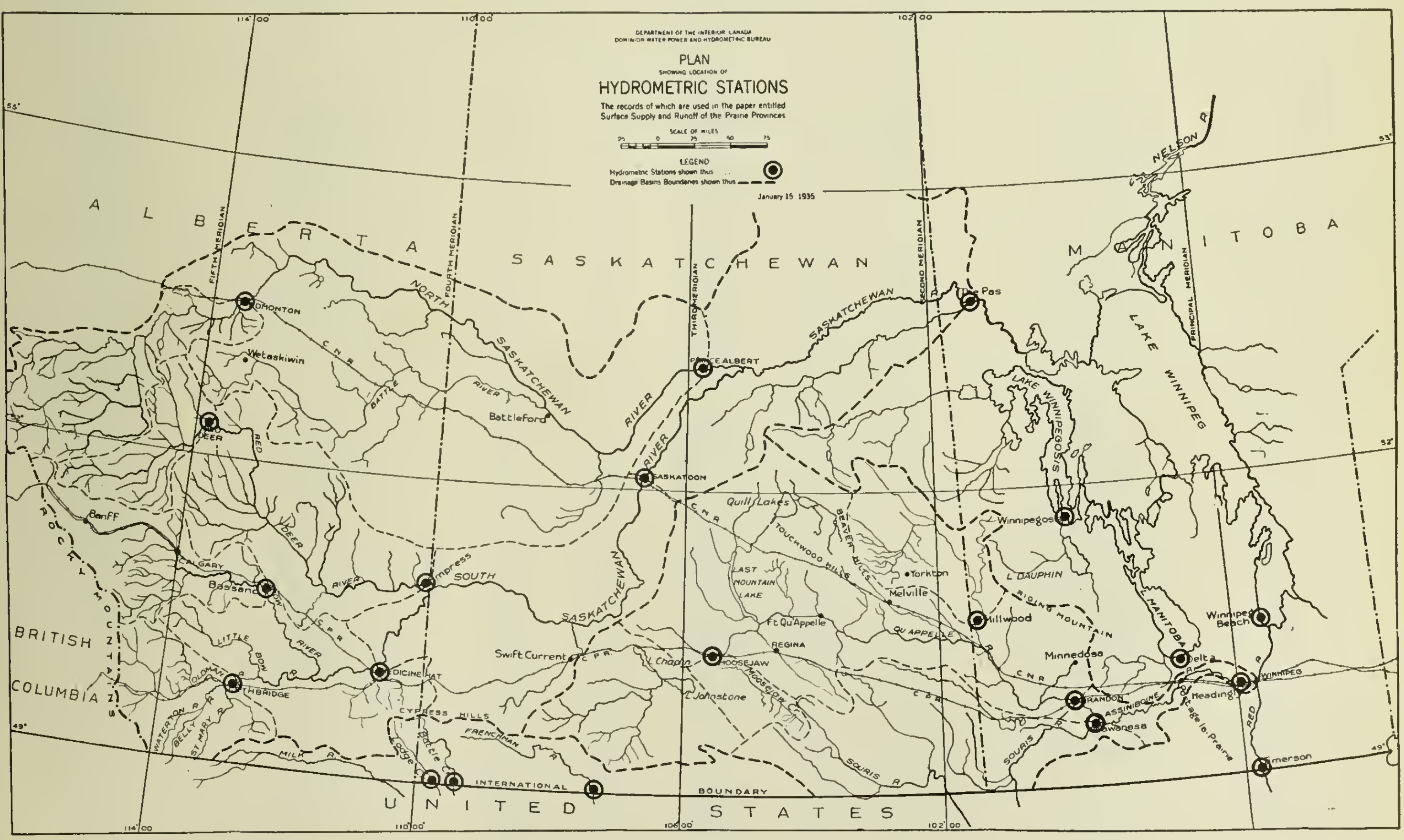

Fig. 1—Location of Hydrometric Stations in Canada.

The towering snow-capped peaks of the Rocky Mountains form the extreme western portion of the area under consideration and supply the source of the Saskatchewan river drainage system. From the mountain area the land drops through a rolling foothill region through the park-like areas of eastern Alberta, merging into the level prairie region of Saskatchewan and then into the lake area of Manitoba.

The runoff from the mountain area, depending upon climatological conditions, is subject to quick and great fluctuations. Floods occur regularly in May and June, after which the flow in the streams gradually decreases until its minimum is reached, in mid winter. The glaciers and perpetual snows provide a dependable runoff throughout the warm weather season. In the lower mountain and foothill area the dense tree growth and thick carpet of vegetation shields the snows of the winters from the spring sun, retarding the runoff and decreasing the liability of the quick and great changes of flow found in the mountain area. From the areas of eastern Alberta the runoff is very small—dependent as it is upon local precipitation.

The runoff from the Saskatchewan plains which include the drought area, is through typical prairie streams. These streams flow in narrow canyon-like channels, in places 300 feet below the original plains. The sparsely wooded hillsides and valleys offer slight resistance to the runoff from the surrounding area. The runoff in these prairie sections, dependent on the local precipitation, is very seasonable. The winter snows rapidly melt in the warm winds and rising temperatures of the spring giving an excessive runoff for a short time. The runoff quickly decreases as summer approaches and is only revived by a heavy local rain.

Data Available for Study

During the past twenty-five years the Dominion through the Department of the Interior has conducted a survey known as the Dominion Hydrometric Survey for the systematic collection and compilation of stream flow of the prairie provinces. This work was initiated as early as 1894 in the provinces of Alberta and Saskatchewan. In the early years it was conducted on a small scale in connection with certain irrigation projects and was confined to summer measurements. In the spring of 1909 the hydrometric survey of the Irrigation Branch was organized on a modern basis and the systematic collection of data pertaining to stream flow of the prairie provinces was begun. In 1912 similar work was initiated by the then Dominion Water Power Branch in the province of Manitoba. In 1920 the responsibility for the Dominion Hydrometric

Table I

Northern Alberta and Saskatchewan

Table of Annual Runoff in acre-feet and equivalent depth in inches per square mile of the North Saskatchewan River at Edmonton and Prince Albert.

Year	Area 10,495 square miles		Area 46,100 square miles		Area 35,605 square miles	
	Mountain flow at Edmonton acre-feet	Inches per square mile	Flow at Prince Albert acre-feet	Inches per square mile	Flow from intervening area acre-feet	Inches per square mile
1	2	3	4	5	6	7
1914-15	8,470,000	15.22	9,940,000	4.04	1,470,000	0.774
16	7,190,000	13.26	8,460,000	3.44	1,270,000	0.665
17	7,130,000	12.71	8,420,000	3.43	1,290,000	0.679
18	5,370,000	9.59	5,280,000	2.16	− 90,000	−0.054
19	4,080,000	7.32	4,270,000	1.73	+ 190,000	+0.095
5 year Mean	6,450,000	11.62	7,270,000	2.96	+ 826,000	0.432
20	6,010,000	10.73	7,770,000	3.16	1,760,000	0.923
21	4,590,000	8.20	5,960,000	2.41	1,370,000	0.719
22	4,470,000	7.97	4,970,000	2.02	500,000	0.258
23	6,410,000	11.46	6,740,000	2.74	330,000	0.176
24	5,220,000	9.33	5,430,000	2.21	210,000	0.109
5 year Mean	5,340,000	9.54	6,174,000	2.51	834,000	0.437
25	6,930,000	12.34	7,080,000	2.88	150,000	0.081
26	6,050,000	10.83	6,240,000	2.54	190,000	0.100
27	7,570,000	13.57	8,770,000	3.53	1,200,000	0.638
28	7,360,000	13.15	7,820,000	3.18	460,000	0.244
29	4,030,000	7.20	4,240,000	1.73	210,000	0.109
5 year Mean	6,390,000	11.42	6,830,000	2.77	446,000	0.236
30	4,440,000	7.93	4,790,000	1.95	350,000	0.184
31	4,570,000	8.16	4,920,000	2.00	350,000	0.184
32	5,900,000	10.54	6,580,000	2.68	680,000	0.358
33	5,330,000	9.52	5,690,000	2.31	360,000	0.189
34	4,190,000	7.48	4,590,000	1.87	400,000	0.211
5 year Mean	4,886,000	8.53	5,314,000	2.16	430,000	0.225
20 year Mean	5,766,000	10.30	6,398,000	2.60	677,500	0 357
1915-28 Mean	6,203,000	11.08	6,940,000	2.82	800,000	0.421
1929-34 Mean	4,778,000	8.54	5,135,000	2.09	392,000	0.206

Survey work was consolidated under the service now known as the Dominion Water Power and Hydrometric Bureau. With the transfer of the natural resources to the prairie provinces the work has been continued by the bureau under co-operative arrangements made with the provinces.

The stream flow records which have been secured constitute a dependable and invaluable record of the surface water supply of the three provinces.

Basis of Study

To analyze the runoff conditions in the drought area it is necessary to determine the flow in the streams derived from other areas.

In this study, the runoff from the mountain and foothill area of Alberta is determined in the North Saskatchewan river from the stream flow records at Edmonton; in the Red Deer river by those at Red Deer; in the Bow river by those at Bassano and in the Oldman river by those at Lethbridge. The runoff from the prairies of eastern Alberta is found in the records of the Red Deer river at Empress and the South Saskatchewan river at Medicine Hat. The runoff from the drainage basin of the Saskatchewan river in western Saskatchewan is found from the records of the South Saskatchewan river at Saskatoon and those of the North Saskatchewan river at Prince Albert, while the records of the Saskatchewan river at The Pas give the runoff from the whole basin.

The records of Moose Jaw Creek at McCarthy's farm near Moose Jaw and those at the International Boundary on Lodge Creek, Battle Creek and Frenchman river give typical runoff from southwestern Saskatchewan.

The runoff from the central and eastern parts of Saskatchewan and southwestern Manitoba is found from the records of the Assiniboine river at Millwood, at Brandon and at Headingly and of the Souris river at Wawanesa. The runoff from southern Manitoba is found in the records of the Red river at Emerson.

Before proceeding with the discussion of the runoff conditions found from these stream flow records, it appears advisable to give a brief description of the individual drainage basins.

Saskatchewan River

The Saskatchewan river may be considered a mountain stream with a more or less dependable source of supply. It consists of two main branches, the North Saskatchewan and the South Saskatchewan, which join just east of Prince Albert to form the main Saskatchewan river which empties into Lake Winnipeg.

Table II

Central Alberta

Table of Annual Runoff in acre-feet and equivalent depth in inches per square mile of the Red Deer River at Red Deer and Empress.

Year	Area 4,480 square miles		Area 1,816 square miles	Area 13,680 square miles	
	Mountain flow at Red Deer acre-feet	Inches per square mile	Flow at Empress acre-feet	Flow from intervening area acre-feet	Inches per square mile
1	2	3	4	5	6
1914-15	3,070,000	12.85	4,050,000	980,000	2.070
16	2,780,000	11.64	3,740,000	960,000	1.938
17	2,260,000	9.49	3,000,000	740,000	1.494
18	1,120,000	4.67	1,310,000	190,000	0.258
19	763,000	3.19	1,090,000	330,000	0.448
5 year Mean	1,730,000	8.37	2,640,000	640,000	1.242
20	1,490,000	6.21	2,330,000	840,000	1.154
21	795,000	3.32	1,100,000	305,000	0.421
22	767,000	3.21	1,020,000	253,000	0.353
23	1,700,000	7.11	1,870,000	170,000	0.231
24	1,170,000	4.91	1,300,000	130,000	0.176
5 year Mean	1,180,000	4.95	1,520,000	340,000	0.467
25	1,160,000	4.83	1,540,000	380,000	0.516
26	1,770,000	7.40	2,270,000	500,000	0.679
27	2,170,000	9.10	2,880,000	710,000	0.977
28	2,240,000	9.39	3,230,000	990,000	1.357
29	980,000	4.10	1,170,000	190,000	0.258
5 year Mean	1,664,000	6.96	2,220,000	560,000	0.757
30	852,000	3.57	1,050,000	198,000	0.271
31	746,000	3.12	982,000	236,000	0.323
32	1,120,000	4.69	1,480,000	360,000	0.493
33	780,000	3.26	1,030,000	250,000	0.343
34	530,000	2.22	699,000	169,000	0.232
5 year Mean	806,000	3.37	1,050,000	243,000	0.333
20 year Mean	1,410,000	5.20	1,860,000	450,000	0.616
1915-28 Mean	1,660,000	6.95	2,200,000	540,000	0.740
1929-34 Mean	835,000	3.49	1,070,000	235,000	0.322

North Saskatchewan River

The North Saskatchewan river draws its principal water supply from the eastern slope of the Rocky Mountains between the 52nd and 53rd parallels. The general direction of the stream is easterly. The drainage basin is bounded on the south by those of the Red Deer and South Saskatchewan rivers and on the north by those of the Athabaska and Churchill rivers.

For a study of the runoff conditions in the North Saskatchewan river, the basin should be divided into three principal areas, but because the records at Edmonton and at Prince Albert are the only complete records of flow in the river for the twenty years, it will be discussed under two areas.

The first area is that part of the drainage basin above Edmonton and includes the mountains and foothill area. From this section which contains the glaciers and the perpetual snows of the mountains and the well wooded slopes of the foothills, the runoff per square mile is greater than from any other section of the basin.

The second area extends from Edmonton to Prince Albert. Its contribution of runoff to the main stream is chiefly through the Sturgeon river which drains the wooded country to the north, the Vermilion and Battle rivers which drain the park-like lands of Alberta and the prairie lands of Saskatchewan south of the main stream.

South Saskatchewan River

The South Saskatchewan river also draws its principal supply from the eastern slope of the Rocky Mountains through its main tributaries, the Red Deer, the Bow and the Oldman rivers. The headwaters of this river extend from the 52nd parallel to south of the International Boundary.

The runoff conditions in this basin are somewhat similar to those in the North Saskatchewan basin and may be divided into the three areas, although because of the size of its mountain tributaries, they have to be considered separately. Considering first the mountain and foothill areas; the mountain flow of the Red Deer is determined at the town of Red Deer; the mountain and foothill flow of the Bow river at Bassano; and the mountain flow of the Oldman river and its tributaries at Lethbridge. The runoff from the second area, or that section of the drainage basin in Alberta other than the mountain and foothill section, is determined at Empress and Medicine Hat. The runoff from the third area, that is to say the open prairie of western Saskatchewan, is recorded at Saskatoon.

Table III

Southern Alberta

Table of Annual Runoff in acre-feet and equivalent depth in inches per square mile of the Bow River at Bassano, the Oldman River at Lethbridge and the South Saskatchewan River at Medicine Hat.

Year	Area 7,613 square miles	Area 6,710 square miles	Area 14,373 square miles	Area 20,600 square miles	Area 6,277 square miles	
	Bow River at Bassano acre-feet	Oldman River at Lethbridge acre-feet	Total Mountain Flow acre-feet	S. Saskatchewan at Medicine Hat acre-feet	Flow from intervening area acre-feet	Inches per square mile
1	2	3	4	5	6	7
1914-15	5,060,000	3,410,000	8,470,000	8,600,000	+130,000	+0.388
16	5,880,000	4,090,000	9,970,000	9,770,000	−200,000	−0.597
17	4,150,000	3,530,000	7,680,000	7,620,000	− 60,000	−0.176
18	2,150,000	2,100,000	4,250,000	4,620,000	+370,000	+1.100
19	2,210,000	1,590,000	3,800,000	3,840,000	+ 40,000	+0.122
5 year Mean	3,890,000	2,940,000	6,830,000	6,890,000	+ 56,000	+0.163
20	3,050,000	2,660,000	5,710,000	5,890,000	+180,000	+0.543
21	2,240,000	2,360,000	4,600,000	4,650,000	+ 50,000	+0.149
22	2,070,000	2,240,000	4,310,000	4,200,000	−110,000	−0.326
23	3,780,000	3,110,000	6,890,000	6,810,000	− 80,000	−0.244
24	2,580,000	1,970,000	4,550,000	4,450,000	−100,000	−0.299
5 year Mean	2,740,000	2,470,000	5,210,000	5,200,000	− 12,000	−0.041
25	2,940,000	2,520,000	5,460,000	5,470,000	+ 10,000	+0.027
26	2,500,000	1,280,000	3,780,000	3,740,000	− 40,000	−0.122
27	4,200,000	4,840,000	9,040,000	9,180,000	+140,000	+0.421
28	4,450,000	4,150,000	8,600,000	7,970,000	−630,000	−1.887
29	2,510,000	2,460,000	4,970,000	4,810,000	−160,000	−0.475
5 year Mean	3,320,000	3,050,000	6,370,000	6,230,000	−136,000	−0.407
30	2,140,000	2,030,000	4,170,000	4,220,000	+ 50,000	+0.149
31	1,410,000	879,000	2,270,000	2,470,000	+180,000	+0.529
32	2,950,000	1,210,000	4,160,000	4,870,000	710,000	2.121
33	2,390,000	2,080,000	4,470,000	5,000,000	530,000	1.583
34	2,380,000	2,900,000	5,280,000	5,280,000	—	—
5 year Mean	2,250,000	1,820,000	4,070,000	4,370,000	300,000	0.891
20 year Mean	3,050,000	2,570,000	5,620,000	5,670,000	+ 50,000	0.149
1915-28 Mean	3,380,000	2,850,000	6,230,000	6,200,000	− 30,000	0.089
1929-34 Mean	2,300,000	1,930,000	4,230,000	4,440,000	210,000	0.627

Main Saskatchewan River

Below the junction of the north and south branches, the main Saskatchewan river passes through central Saskatchewan and is joined near The Pas by the Carrot and Pasquia rivers which drain the open prairies to the south of the river.

Red River

The Red river may be considered as a typical prairie stream, whose flow—because the source of supply is from the winter snows, from springs and from prairie areas where the precipitation is low—is not as dependable as that of the Saskatchewan river.

The Red river, one of the most important flowing in the province of Manitoba, has its source near the central part of the state of Minnesota. It crosses the International Boundary at the town of Emerson and flows in a northerly direction to empty in Lake Winnipeg. The drainage basin of the river is 116,347 square miles, of which 50,500 are in Saskatchewan and 23,300 are in Manitoba. As the Red river is the oldest district in Manitoba and practically all settled, little standing timber is to be found.

Assiniboine River

The main tributary to the Red river in Canada and of more interest in this discussion, is the Assiniboine river which joins the main stream at Winnipeg. Its source is in the province of Saskatchewan from the southeastern slope of Beaver Hills. It flows in a southeasterly direction through Saskatchewan and Manitoba. Of the total drainage area of the Assiniboine river, 37,700 square miles are in Saskatchewan and 13,050 square miles in Manitoba. The area drained varies between open prairie found in its southern reaches to the well wooded areas in Duck and Riding Mountains. This river is important as a source of water supply and as a means of drainage and sewage disposal in the most densely populated part of Manitoba where the natural water supply is limited. The principal tributaries to the Assiniboine river are the Qu'Appelle and Souris rivers.

Moose Jaw Creek and Runoff from Cypress Hills

In addition to the two main drainage systems, two minor representative drainage basins of differing physical characteristics in southwestern Saskatchewan have been investigated. The Moose Jaw creek, a tributary to the headwaters of the Qu'Appelle river, drains the open prairie south of Moose Jaw, and its runoff is entirely dependent on local precipitation. The runoff in Lodge Creek, Battle Creek and Frenchman river, which has been taken as from one drainage basin, has its source in the wooded slopes of the Cypress Hills.

Table IV

Central Saskatchewan

Table of Annual Runoff in acre-feet and equivalent depth in inches per square mile of the Red Deer River at Empress, of South Saskatchewan River at Medicine Hat and Saskatoon.

Year	Area 18,160 square miles	Area 20,600 square miles	Area 38,760 square miles	Area 50,900 square miles	Area 12,140 square miles	
	Red Deer River at Empress acre-feet	S. Saskatchewan at Medicine Hat acre-feet	Total acre-feet	S. Saskatchewan at Saskatoon acre-feet	Flow from intervening area acre-feet	Inches per square mile
1	2	3	4	5	6	7
1914-15	4,050,000	8,600,000	12,650,000	12,800,000	150,000	0.232
16	3,740,000	9,770,000	13,510,000	14,600,000	1,090,000	0.991
17	3,000,000	7,620,000	10,620,000	11,300,000	680,000	0.624
18	1,310,000	4,620,000	5,930,000	6,110,000	180,000	0.278
19	1,090,000	3,840,000	4,930,000	4,840,000	− 90,000	−0.136
5 year Mean	2,280,000	6,890,000	9,170,000	9,930,000	402,000	0.623
20	2,330,000	5,890,000	8,220,000	8,520,000	300,000	0.462
21	1,100,000	4,650,000	5,750,000	5,670,000	− 80,000	−0.014
22	1,020,000	4,200,000	5,220,000	5,640,000	420,000	0.652
23	1,870,000	6,810,000	8,680,000	8,360,000	− 320,000	−0.489
24	1,300,000	4,450,000	5,750,000	5,920,000	170,000	0.258
5 year Mean	1,520,000	5,200,000	6,720,000	6,820,000	100,000	0.149
25	1,540,000	5,470,000	7,010,000	7,300,000	290,000	0.448
26	2,270,000	3,740,000	6,010,000	6,010,000	—	—
27	2,880,000	9,180,000	12,060,000	13,100,000	1,040,000	1.601
28	3,230,000	7,970,000	11,200,000	12,100,000	900,000	1.385
29	1,170,000	4,810,000	5,980,000	6,450,000	470,000	0.719
5 year Mean	2,220,000	6,230,000	8,450,000	8,990,000	540,000	0.828
30	1,050,000	4,220,000	5,270,000	5,460,000	190,000	0.299
31	982,000	2,470,000	3,450,000	3,490,000	40,000	0.068
32	1,480,000	4,870,000	6,350,000	6,690,000	340,000	0.525
33	1,030,000	5,000,000	6,030,000	6,290,000	260,000	0.402
34	699,000	5,280,000	5,980,000	6,150,000	170,000	0.263
5 year Mean	1,050,000	4,370,000	5,420,000	5,620,000	200,000	0.309
20 year Mean	1,860,000	5,670,000	7,530,000	7,840,000	310,000	0.479
1915-28 Mean	2,200,000	6,200,000	8,400,000	8,730,000	330,000	0.510
1929-34 Mean	1,070,000	4,440,000	5,510,000	5,760,000	250,000	0.386

Analysis of Records

As mentioned in the foregoing the period under investigation in this paper is a twenty-year period—from October 1st, 1914, to September 30th, 1934. The material is compiled by water years, i.e. each year extending from and inclusive of the month of October to the month of September in the following year, thus taking cognizance of that portion of each season's winter precipitation which is held in frozen form to augment the runoff of the succeeding season.

In the tabular matter compiled herein records have been taken for the full water year—October to September—on the main streams. On the tributaries the records tabulated include only open water flow during April to the end of October, while on the Souris river they only include May to the end of October.

It is unfortunate that, as a result of the curtailment of field operations owing to the administrative retrenchment made necessary by economic conditions in the past few years, continuous runoff records are not available at a few of the stations involved in the analysis. Where such records were missing it has been necessary to prepare an estimate of the flow based upon such records as were to hand backed by the experienced knowledge of the hydrometric engineers on the ground.

For the purpose of presenting the material in a form that can be readily studied by those concerned in the drought situation, a series of tables has been prepared and is included herewith. The runoff has been compiled in the form of total acre-feet per water year and the depth in inches per square mile to which this runoff would be equivalent if applied to the area drained. This permits of an immediate comparison of the total supply from year to year, and by cycles.

The material has been compiled by five-year means in order that general comparisons or trends, if any, may be noted. The twenty-year mean is also recorded. Following the initial tabulations it became evident that in certain areas the low runoff cycle commenced in 1929; it has continued for the last six years. Taking cognizance of this, the tables have been extended to record the mean for the fourteen years before the period of low runoff and also the mean of the six years of low runoff.

Comment on Tables

Tables I to X, inclusive, deal with the runoff from the various individual areas under review and show the areas in square miles, the annual or seasonal runoff in acre feet and equivalent depth in inches per square mile of the drainage basin and the means for the different periods men-

Table V

Northern Saskatchewan

Table of Annual Runoff in acre-feet and equivalent depth in inches per square mile of the South Saskatchewan River at Saskatoon, the North Saskatchewan River at Prince Albert and the Saskatchewan River at The Pas.

Year	Area 50,900 square miles	Area 46,100 square miles	Area 97,000 square miles	Area 149,500 sq. miles	Area 52,500 square miles	
	S. Saskatchewan at Saskatoon acre-feet	N. Saskatchewan at Prince Albert acre-feet	Total acre-feet	Saskatchewan at The Pas acre-feet	Flow from intervening area acre-feet	Inches per square mile
1	2	3	4	5	6	7
1914-15	12,800,000	9,940,000	22,740,000	23,980,000	1,240,000	0.443
16	14,600,000	8,460,000	23,060,000	28,370,000	5,310,000	1.896
17	11,300,000	8,420,000	19,720,000	27,240,000	7,520,000	2.686
18	6,110,000	5,280,000	11,390,000	17,140,000	5,750,000	2.054
19	4,840,000	4,270,000	9,110,000	12,270,000	3,160,000	1.129
5 year Mean	9,930,000	7,270,000	17,200,000	21,800,000	4,600,000	1.642
20	8,520,000	7,770,000	16,390,000	19,320,000	2,930,000	1.045
21	5,670,000	5,960,000	11,630,000	18,010,000	6,380,000	2.280
22	5,640,000	4,970,000	10,610,000	17,490,000	6,880,000	2.451
23	8,360,000	6,740,000	15,100,000	20,200,000	5,100,000	1.819
24	5,920,000	5,430,000	11,350,000	13,910,000	2,560,000	0.914
5 year Mean	6,820,000	6,170,000	12,990,000	17,790,000	4,800,000	1.714
25	7,300,000	7,080,000	14,380,000	17,870,000	3,490,000	1.252
26	6,010,000	6,240,000	12,250,000	15,070,000	2,820,000	1.007
27	13,100,000	8,770,000	21,870,000	27,060,000	5,190,000	1.854
28	12,100,000	7,820,000	19,920,000	25,310,000	5,390,000	1.925
29	6,450,000	4,240,000	10,690,000	11,590,000	900,000	0.326
5 year Mean	8,990,000	6,830,000	15,820,000	19,380,000	3,560,000	1.271
30	5,460,000	4,790,000	10,250,000	11,660,000	1,410,000	0.504
31	3,490,000	4,920,000	8,410,000	10,630,000	2,220,000	0.787
32	6,690,000	6,580,000	13,270,000	18,440,000	5,170,000	1.846
33	6,290,000	5,690,000	11,980,000	17,260,000	5,280,000	1.887
34	6,150,000	4,590,000	10,740,000	18,220,000	7,480,000	2.671
5 year Mean	5,620,000	5,310,000	10,930,000	15,240,000	4,310,000	1.539
20 year Mean	7,840,000	6,400,000	14,240,000	18,550,000	4,310,000	1.539
1915-28 Mean	8,730,000	6,940,000	15,670,000	20,230,000	4,560,000	1.629
1929-34 Mean	5,755,000	5,135,000	10,890,000	14,630,000	3,740,000	1.336

tioned. Table XI is a summary of the first ten tables and shows the runoff in inches depth per square mile of the drainage basin in the different areas studied.

Table XII is the tabulation of the mean annual water level in the three lakes, Winnipegosis, Manitoba and Winnipeg.

Saskatchewan River Basin

An analysis of the tables reveals that the runoff from the first or mountain area was fairly consistent during the first fourteen years of the twenty years record, but during the last six years, while nearly normal in the North Saskatchewan basin, dropped to 59 per cent of the twenty-year mean in the Red Deer basin and to 75 per cent in the South Saskatchewan.

Table I, column 2, indicates that the flow of the North Saskatchewan river at Edmonton during the past six years was 81 per cent of the twenty-year mean and 77 per cent of the mean of the preceding fourteen years. Table II, column 2, indicates that the flow of the Red Deer river at Red Deer during the last six years was 59 per cent of the twenty-year mean and only half of the mean for the preceding fourteen years. Table III combines the flow of the flow of the Bow river at Bassano with that in the Oldman river at Lethbridge, and column 4 indicates that this combined flow from the mountain area, during the last six years was 75 per cent of the twenty-year mean and 68 per cent of the mean for the preceding fourteen years.

The second area considered on the North Saskatchewan river lies between Edmonton and Prince Albert, consequently, the increment between these stations indicates the runoff from eastern Alberta and western Saskatchewan. During the last six years, this increment as determined in Table I, column 6, was only 58 per cent of the twenty-year mean and 49 per cent of the mean of the preceding fourteen years.

In the South Saskatchewan river basin, the runoff from the second area considered, which is in central and southern Alberta, is shown from Table II, column 5, and from Table III, column 6.

Table II, column 5, indicates that the mean inflow to Red Deer river between Red Deer and Empress during the last six years was 53 per cent of the twenty-year mean and 44 per cent of the mean of the preceding fourteen years.

Table III, column 6, indicates that the mean inflow to the South Saskatchewan river from the drainage area in the Bow river between Bassano and Medicine Hat and on the Oldman river between Lethbridge and Medicine Hat during the last six years was considerably greater than both the twenty-year mean and the mean for the preceding fourteen years. Column 6 also indicates that the mean runoff from

TABLE VI

SOUTHWESTERN SASKATCHEWAN

Table of Open Water Runoff in acre-feet and equivalent depth in inches per square mile of Lodge Creek, Battle Creek and Frenchman River at the International Boundary.

Year	Area 797 square miles		Area 726 square miles		Area 1,875 square miles		Area 3,398 square miles	
	Lodge Cr. acre-feet	Inches per square mile	Battle Cr. acre-feet	Inches per square mile	Frenchman R. acre-feet	Inches per square mile	Total acre-feet	Inches per square mile
1	2	3	4	5	6	7	8	9
1915	29,400	0.692	33,900	1.271	59,700	0.597	123,000	0.678
16	55,300	1.301	93,400	3.502	216,000	2.160	364,700	2.012
17	64,600	1.520	85,600	2.211	174,000	1.740	324,200	1.789
18	57,100	1.343	54,300	1.402	71,700	0.717	183,100	1.010
19	7,900	0.186	5,530	0.143	28,900	0.289	42,330	0.233
5 year Mean	42,900	1.008	54,500	1.706	110,000	1.100	207,400	1.144
20	22,400	0.527	26,200	0 677	80,300	0.803	128,900	0.711
21	23,200	0.546	19,500	0.504	47,900	0.479	90,600	0.500
22	46,300	1.089	53,400	1.379	114,000	1.140	213,700	1.179
23	18,900	0.445	16,900	0.436	93,200	0.932	129,000	0.712
24	4,440	0.104	9,480	0.245	32,700	0.327	46,600	0.257
5 year Mean	23,000	0.542	25,100	0.648	73,600	0.736	121,700	0.672
25	42,300	0.995	43,300	1.118	132,000	1 320	217,600	1.190
26	10,100	0.238	7,110	0.184	55,600	0.556	72,810	0.402
27	82,200	1.934	97,800	2.526	200,000	2.000	380,000	2.096
28	39,000	0.918	48,600	1.255	107,000	1.070	194,600	1.074
29	16,800	0.395	23,700	0.612	34,200	0.342	74,700	0.412
5 year Mean	38,100	0.896	44,100	1.139	105,800	1.058	188,000	1.037
30	16,400	0.489	31,400	0.811	80,200	0.802	128,000	0.731
31	489	0.011	2,450	0.063	11,600	0.116	14,540	0.080
32	9,880	0.220	11,500	0.297	43,400	0.434	64,780	0.364
33	12,600	0.296	14,400	0.372	33,100	0.331	60,100	0.322
34	15,700	0.330	12,100	0.312	20,200	0.202	48,000	0.265
5 year Mean	11,000	0.269	14,400	0.371	37,700	0.377	63,100	0.352
20 year Mean	28,800	0.678	34,500	0.891	77,000	0.770	145,600	0.803
1915-28Mean	35,900	0.821	42,500	1.098	94,000	0.940	172,400	0.951
1929-34Mean	12,000	0.282	15,900	0.411	37,800	0.378	65,700	0.358

this area for the period 1915 to 1928 is a negative quantity, showing that the losses during this period exceed the inflow. It may be explained that the large irrigation projects in southern Alberta are located in this particular area and the runoff records are influenced by the use of water on these irrigation projects.

The increment to the South Saskatchewan river between Medicine Hat and Saskatoon is contributed from southwestern Saskatchewan and has been fairly consistent. Table IV, column 6, shows that the mean of this increment during the last six years was 80 per cent of the twenty-year mean and 76 per cent of the mean of the preceding fourteen years.

The inflow to the main stream east of Prince Albert as seen in Table V, column 6, has been fairly consistent as the mean for the last six years was 87 per cent of the twenty-year mean and 82 per cent of the mean of the preceding fourteen years.

Mississippi River Basin

The runoff from the Cypress Hills as determined in Table VI, column 8, during the last six years was 45 per cent of the twenty-year mean and 38 per cent of the mean for the preceding fourteen years. The records show that approximately 70 per cent of the open water flow from this basin occurs before May.

Red-Assiniboine Basin

The mean runoff from Moose Jaw creek near Moose Jaw as shown in Table VII, column 2, during the last six years was 15 per cent of the twenty-year mean and 11 per cent of the mean of the preceding fourteen years, while the flow of 1934 was only 2 per cent of the twenty-year mean. The records show that 73 per cent of the runoff from this basin occurs before May.

From the Assiniboine river basin may be determined the runoff conditions in eastern, central and southeastern Saskatchewan and from southwestern Manitoba.

The runoff during the open water period from southeastern Saskatchewan and southwestern Manitoba is recorded in the Assiniboine river at Millwood. The mean runoff from this area as indicated in Table VIII, column 2, during the last six years was 39 per cent of the twenty-year mean and 30 per cent of the mean of the fourteen preceding years.

The mean runoff from the Qu'Appelle river as determined in Table VIII, column 6, during the last six years was 33 per cent of the twenty-year mean and 26 per cent of the mean of the preceding fourteen years, while the mean runoff from the Souris river at Wawanesa as shown in Table VII, column 4, during the last six years was 22 per cent of the twenty-year mean and 16 per cent of the mean of the preceding fourteen years.

Table VII

South Eastern Saskatchewan

Table of Open Water Runoff in acre-feet and equivalent depth in inches per square mile of Moose Jaw Creek near Moose Jaw and Souris River at Wawanesa.

Year	Area 1,719 square miles		Area 23,400 square miles	
	Moose Jaw Cr. Moose Jaw acre-feet	Inches per square mile	Souris R. at Wawanesa acre-feet	Inches per square mile
1	2	3	4	5
1915	137	0.001	13,700	0.011
16	101,400	1.106	313,000	0.251
17	50,500	0.552	108,000	0.086
18	15,400	0.168	25,100	0.020
19	11,800	0.126	90,200	0.072
5 year Mean	35,800	0.391	110,000	0.088
20	42,600	0.465	192,000	0.154
21	4,860	0.053	44,800	0.033
22	53,200	0.580	112,000	0.090
23	68,300	0.745	288,000	0.231
24	22,800	0.249	69,300	0.056
5 year Mean	38,400	0.418	141,000	0.113
25	63,900	0.697	176,000	0.141
26	5,350	0.058	25,900	0.021
27	98,600	1.075	483,000	0.387
28	24,300	0.265	316,000	0.253
29	367	0.004	43,300	0.034
5 year Mean	38,500	0.420	209,000	0.167
30	11,400	0.124	54,700	0.044
31	1,700	0.019	1,230	0.001
32	6,200	0.068	9,950	0.008
33	7,050	0.077	42,400	0.034
34	692	0.008	6,540	0.005
5 year Mean	5,400	0.059	23,000	0.018
20 year Mean	29,500	0.322	121,000	0.097
1915-28 Mean	40,200	0.431	161,000	0.129
1929-34 Mean	4,570	0.050	26,400	0.021

The runoff of the Red river as recorded at Emerson also shows a falling off during the last six years. Table X, column 2, indicates that the mean of the last six years was 29 per cent of the twenty-year mean and 22 per cent of the mean of the preceding fourteen years.

Manitoba Lakes

The levels of Lake Manitoba, Lake Winnipegosis and Lake Winnipeg as recorded in Table XII, during the last six years all show about one foot lower elevation than the mean level of the twenty-year period and about one foot and a half lower than the mean of the preceding fourteen years.

Summary

The foregoing review of runoff records for the twenty-year period 1914-1934 indicates that the flow of streams having mountain supply as their source, such as the tributaries of the Saskatchewan river, has not suffered during the recent dry years to anything like the extent experienced in the streams fed from prairie drainage in southern Saskatchewan and southwestern Manitoba.

The runoff from mountain sources has been fairly consistent, and, although it has decreased somewhat during the last six years, an average of approximately 80 per cent of normal flow has been maintained in these years. In other words the snow-capped mountain areas have constituted a fairly dependable source of supply throughout the drought period, to the river systems originating therein.

On the other hand, the runoff from prairie sources has decreased excessively during the last six years, the mean of these years being from 20 per cent to 30 per cent of normal quantity. This is particularly the case in southern Saskatchewan and southwestern Manitoba where flows in some of the streams during the open water period of 1934 have been as low as 5 per cent of the twenty-year mean, and all streams have shown an extraordinary diminution in flow.

Table VIII

East Central Saskatchewan

Table of Open Water Runoff in acre-feet and equivalent depth in inches per square mile of the Assiniboine River at Millwood and Brandon.

Year	Area 7,590 square miles		Area 34,500 square miles	Area 7,590 square miles	Area 26,910 square miles	
	Assiniboine R. at Millwood acre-feet	Inches per square mile	Assiniboine R. at Brandon acre-feet	Assiniboine R. at Millwood acre-feet	Flow from Qu'Appelle R. acre-feet	Inches per square mile
1	2	3	4	5	6	7
1915	113,000	0.279	200,000	113,000	87,000	0.061
16	366,000	0.904	914,000	366,000	548,000	0.382
17	504,000	1.245	856,000	504,000	352,000	0.245
18	202,000	0.499	314,000	202,000	112,000	0.078
19	237,000	0.586	414,000	237,000	177,000	0.123
5 year Mean	284,000	0.703	540,000	284,000	255,000	0.178
20	544,000	1.344	795,000	544,000	251,000	0.175
21	964,000	2.381	1,160,000	964,000	196,000	0.136
22	1,400,000	3.458	1,990,000	1,400,000	590,000	0.411
23	868,000	2.144	1,990,000	868,000	1,122,000	0.782
24	224,000	0.533	654,000	224,000	430,000	0.300
5 year Mean	800,000	1.972	1,318,000	800,000	518,000	0.361
25	452,000	1.117	1,180,000	452,000	728,000	0.507
26	249,000	0.615	382,000	249,000	133,000	0.092
27	843,000	2.083	1,890,000	843,000	1,047,000	0.730
28	471,000	1.164	1,020,000	471,000	549,000	0 382
29	177,000	0.437	301,000	177,000	124,000	0.086
5 year Mean	438,000	1.083	955,000	438,000	517,000	0.359
30	145,000	0.358	308,000	145,000	163,000	0.113
31	103,000	0.254	119,000	103,000	16,000	0.011
32	128,000	0.316	176,000	128,000	48,000	0.033
33	240,000	0.593	440,000	240,000	200,000	0.160
34	198,000	0.489	346,000	198,000	148,000	0.100
5 year Mean	163,000	0.502	278,000	163,000	115,000	0.083
20 year Mean	421,000	1.040	772,000	421,000	351,000	0.245
1915-28 Mean	531,000	1.312	983,000	531,000	452,000	0.315
1929-34 Mean	165,000	0.408	282,000	165,000	117,000	0.082

Table IX

Southern Manitoba

Table of Open Water Runoff in acre-feet and equivalent depth in inches per square mile of the Assiniboine River at Brandon and Headingly and the Souris River at Wawanesa.

Year	Area 34,500 square miles	Area 23,400 square miles	Area 57,900 square miles	Area 62,760 square miles	Area 4,860 square miles	
	Assiniboine R. at Brandon acre-feet	Souris R. at Wawanesa acre-feet	Total acre-feet	Assiniboine R. at Headingly acre-feet	Flow from intervening area acre-feet	Inches per square mile
1	2	3	4	5	6	7
1915	147,000	13,700	161,000	213,000	52,000	0 201
16	671,000	313,000	984,000	1,140,000	156,000	0.602
17	744,000	108,000	852,000	998,000	146,000	0.563
18	210,000	25,100	235,000	328,000	93,000	0.359
19	239,000	90,200	329,000	438,000	109,000	0.421
5 year Mean	402,000	110,000	512,000	623,000	111,000	0.429
20	675,000	192,000	867,000	954,000	87,000	0.336
21	941,000	44,800	986,000	1,096,000	110,000	0.424
22	1,720,000	112,000	1,832,000	1,904,000	72,000	0.278
23	1,720,000	288,000	2,008,000	2,211,000	203,000	0.783
24	522,000	69,300	591,000	741,000	150,000	0.579
5 year Mean	1,116,000	141,000	1,257,000	1,381,000	122,000	0.480
25	698,000	176,000	874,000	1,058,000	184,000	0.710
26	267,000	25,900	293,000	398,000	105,000	0.405
27	1,590,000	483,000	2,073,000	2,321,000	248,000	0.957
28	706,000	316,000	1,022,000	1,259,000	237,000	0.914
29	222,000	43,300	265,000	375,000	110,000	0.424
5 year Mean	697,000	209,000	906,000	1,082,000	176,000	0.682
30	186,000	54,700	241,000	388,000	147,000	0 567
31	78,800	1,230	80,000	133,000	53,000	0 204
32	134,000	9,950	144,000	213,000	69,000	0.266
33	279,000	42,400	321,000	429,000	108,000	0.417
34	186,000	6,540	193,000	288,000	95,000	0.366
5 year Mean	172,600	23,000	196,000	290,000	94,400	0.364
20 year Mean	597,000	121,000	718,000	844,000	126,000	0.486
1915-28 Mean	775,000	161,000	936,000	1,076,000	140,000	0.540
1929-34 Mean	181,000	26,400	207,400	304,000	96,600	0.373

Table X

Southern Manitoba

Table of Open Water Runoff in acre feet and equivalent depth in inches per square mile of Red river at Emerson and Assiniboine River between Brandon and Headingly.

Year	Area 34,600 square miles		Area 4,860 square miles
	Red River at Emerson acre-feet	Inches per square mile	Assiniboine River—Inches per square mile
1	2	3	4
1915	1,740,000	0.943	0.201
16	3,160,000	1.712	0.602
17	710,000	0.385	0.563
18	419,000	0.227	0.359
19	1,240,000	0.672	0.421
5 year Mean	1,454,000	0.788	0.429
20	991,000	0.537	0.336
21	589,000	0.319	0.424
22	891,000	0.483	0.278
23	869,000	0.471	0.783
24	415,000	0.225	0.579
5 year Mean	751,000	0.407	0.480

TABLE X—Continued

Year	Area 34,600 square miles		Area 4,860 square miles
	Red River at Emerson acre-feet	Inches per square mile	Assiniboine River—Inches per square mile
1	2	3	4
1925	1,060,000	0.574	0.710
26	482,000	0.261	0.405
27	1,900,000	1.030	0.957
28	1,020,000	0.553	0.914
29	384,000	0.208	0.424
5 year Mean	969,000	0.515	0.682
30	546,000	0.285	0.567
31	135,000	0.073	0.204
32	178,000	0.096	0.266
33	180,000	0.098	0.417
34	68,000	0.037	0.366
5 year Mean	221,000	0.118	0.364
20 year Mean	849,000	0.460	0.486
1915-28 Mean	1,106,000	0.600	0.540
1929-34 Mean	248,500	0.135	0.373

TABLE XI

SUMMARY

Table of Runoff in depth in inches per square mile from sections of Alberta, Saskatchewan and Manitoba.

Year	Alberta			Saskatchewan			
	Table I	Table II	Table III	Table V	Table IV	Table VIII	Table VIII
	Northern	Central	Southern	Northern	Central	East Central	
1	2	3	4	5	6	7	8
1915	0.774	2.070	0.388	0.445	0.232	0.279	0.061
16	0.665	1.938	−0.597	1.900	0.991	0.904	0.382
17	0.679	1.494	−0.176	2.674	0.624	1.245	0.245
18	−0.054	0.258	+1.100	2.050	0.278	0.499	0.078
19	0.095	0.448	0.122	1.127	−0.136	0.586	0.123
5 year Mean	0.432	1.242	0.163	1.642	0.623	0.703	0.178
20	0.923	1.154	0.543	1.032	0.462	1.344	0.175
21	0.719	0.421	0.149	2.280	−0.014	2.381	0.136
22	0.258	0.353	−0.326	2.443	0.652	3.458	0.411
23	0.176	0.231	−0.224	1.819	−0.489	2.144	0.782
24	0.109	0.176	−0.299	0.882	0.258	0.533	0.300
5 year Mean	0.437	0.467	−0.041	1.697	0.149	1.972	0.361
25	0.081	0.516	0.027	1.249	0.448	1.117	0.507
26	0.109	0.679	−0.122	1.004	—	0.615	0.092
27	0.638	0.977	+0.421	1.860	1.601	2.083	0.730
28	0.244	1.357	−1.887	1.859	1.385	1.164	0.382
29	0.109	0.258	−0.475	0.326	0.719	0.437	0.086
5 year Mean	0.236	0.757	−0.407	1.262	0.828	1.083	0.359
30	0.184	0.271	+0.149	0.502	0.299	0.358	0.113
31	0.184	0.323	+0.529	0.787	0.068	0.254	0.011
32	0.358	0.493	2.121	1.846	0.525	0.316	0.033
33	0.189	0.343	1.583	1.887	0.402	0.593	0.160
34	0.211	0.232	—	2.671	0.263	0.489	0.100
5 year Mean	0.225	0.333	0.891	1.539	0.309	0.502	0.083
20 year Mean	0.357	0.616	0.149	1.539	0.479	1.040	0.245
1915-28 Mean	0.421	0.740	0.089	1.629	0.510	1.312	0.315
1929-34 Mean	0.206	0.322	0.627	1.336	0.386	0.408	0 082

Table XI—Continued

Summary

Table of Runoff in depth in inches per square mile from sections of Alberta, Saskatchewan and Manitoba

Year	Saskatchewan			Manitoba	
	Table VI	Table VII	Table VII	Table IX	Table X
	S. Western	S. Eastern	S. Eastern	Southern	N. Dakota
	9	10	11	12	13
1915	0.678	0.001	0.011	0.201	0.943
16	2.012	1.106	0.251	0.602	1.712
17	1.789	0.552	0.086	0.563	0.385
18	1.010	0.168	0.020	0.359	0.227
19	0.233	0.126	0.072	0.421	0.672
5 year Mean	1.144	0.391	0.088	0.429	0.788
20	0.711	0.465	0.154	0.336	0.537
21	0.500	0.053	0.033	0.424	0.319
22	1.179	0.580	0.090	0.278	0.483
23	0.712	0.745	0.231	0.783	0.471
24	0.257	0.249	0.056	0.579	0.225
5 year Mean	0.672	0.418	0.113	0.480	0.407
25	1.190	0.697	0.141	0.710	0.574
26	0.402	0.058	0.021	0.405	0.261
27	2.096	1.075	0.387	0.957	1.030
28	1.074	0.265	0.253	0.914	0.553
29	0.412	0.004	0.034	0.424	0.208
5 year Mean	1.037	0.420	0.167	0.682	0.515
30	0.731	0.124	0.044	0.567	0.285
31	0.080	0.019	0.001	0.204	0.073
32	0.364	0.068	0.008	0.266	0.096
33	0.322	0.077	0.034	0.417	0.098
34	0.265	0.008	0.005	0.366	0.037
5 year Mean	0.352	0.059	0.018	0.364	0.118
20 year Mean	0.803	0.322	0.097	0.486	0.460
1915-28 Mean	0.951	0.431	0.129	0.540	0.600
1929-34 Mean	0.362	0.050	0.021	0.373	0.135

Table XII

Lake Levels

Table of mean annual lake level, referred to sea datum, of Lake Manitoba, Lake Winnipegosis and Lake Winnipeg.

Year	Lake Manitoba feet	Lake Winnipegosis feet	Lake Winnipeg feet
1	2	3	4
1914-15	812.39	831.21	711.51
16	811.89	830.53	712.46
17	811.88	831.53	713.78
18	811.87	831.51	712.68
19	811.78	830.51	711.68
5 year Mean	811.96	831.06	712.42
20	811.30	830.56	711.68
21	811.18	830.90	711.78
22	812.20	832.80	712.34
23	813.20	832.77	712.03
24	813.04	832.23	711.83
5 year Mean	812.18	831.85	711.93
25	812.72	831.67	711.59
26	812.45	831.62	712.10
27	812.20	831.21	713.38
28	812.58	832.09	714.45
29	811.89	830.69	712.67
5 year Mean	812.37	831.46	712.84

Table XII—Continued

Year	Lake Manitoba feet	Lake Winnipegosis feet	Lake Winnipeg feet
1	2	3	4
1930	811.18	829.87	710.74
31	810.73	829.58	710.16
32	811.30	829.38	710.07
33	810.43	829.50	710.68
34	810.39	830.46	711.48
5 year Mean	810.81	829.76	710.63
20 year Mean	811.83	831.03	711.95
1915-28 Mean	812.19	831.51	712.38
1929-34 Mean	810.99	829.91	710.97

Some Possible Sources of Ground Water in Southern Saskatchewan

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., Feb 7thand 8th, 1935.

SUMMARY—Possible sources of ground water in southern Saskatchewan are from some of the bedrock formations and in places from the glacial drift and recent alluvium. Bedrock formations that are known to yield water are mostly confined to the western and southern parts of the province. The water from some of them is mineralized. The water in the surface deposits or glacial drift occurs in buried stream channels, in sand and gravel beds covered by lake clay or boulder clay, in glacial outwash and gravel and in recent alluvium in the present stream valleys. In places artesian water occurs in sands and gravels overlain by clay.

The study of ground water problems in southern Saskatchewan has been a subject of investigation by the Geological Survey for several years. Thus far a preliminary study has been made; the surface deposits and bedrock formations have been mapped and detailed surveys made of areas around Moose Jaw, Regina and the district covered by the Rush Lake sectional sheet and part of the Elbow sheet. The area around Regina was studied by Professor Howard E. Simpson.[1] W. A. Johnston[2] and the present author reported on the underground water conditions in the vicinity of Moose Jaw. Two reports by D. C. Maddox[3] described ground water conditions in the Rush Lake sheet and the eastern part of the Elbow sheet.

Most of the information used in this paper has been obtained by the author while mapping the surface deposits between longitude 102 degrees to 109 degrees and latitude 49 degrees to 52 degrees. These are practically the limits of the area referred to as southern Saskatchewan in this paper. W. A. Johnston[4] in his report on the Winnipeg map area has reported on the district between the Saskatchewan-Manitoba boundary and the second meridian.

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1 Simpson, Howard E., Geol. Surv. Canada Summ. Rept. 1929, pt. B., pp. 65-111 (1930).

2 Johnston, W. A., and Wickenden, R. T. D., Geol. Surv. Summ. Rept. 1930, pt. B. pp. 50-65 (1931).

3 Maddox, D. C., Geol. Surv. Summ. Rept. 1931, pt. B., pp. 58-71, 1932; *Ibid.* 1932, pt. B., pp. 75-89 (1933).

4 Bureau of Economic Geology, Ottawa, Mem. 174, 1934.

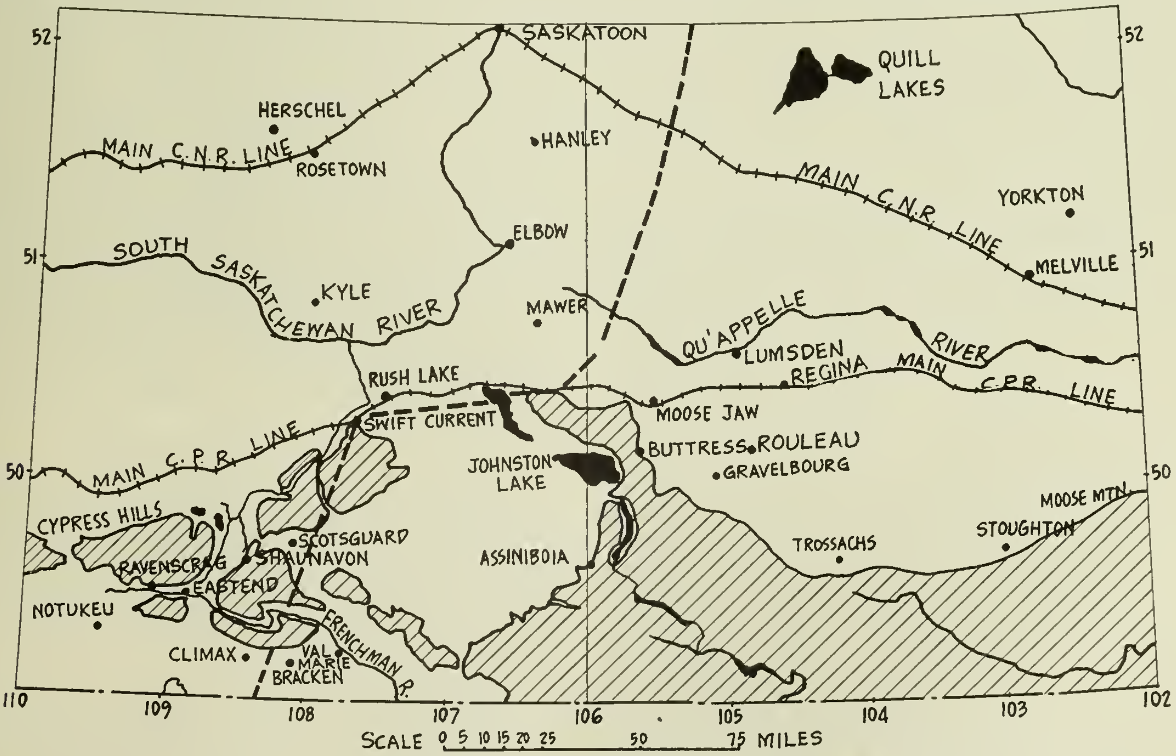

Fig. 1—Sketch Map of Southern Saskatchewan: shaded area underlain by Ravenscrag and Tertiary Formations; broken line indicates approximate eastern limit of area in which water bearing sands occur in the Belly River and Bearpaw Formations.

The present paper gives only a general account of the modes of occurrence of ground water in parts of the region. Much more work needs to be done before it will be possible to state in what areas water may be obtained by drilling and in what areas it is not possible. It is known that in some areas little or no water is obtainable by drilling.

Bedrock Waters

Ground waters in southern Saskatchewan may be considered as belonging geologically to two general classes: those that occur in the bedrock and those that occur in the glacial drift and recent alluvium. The term bedrock as used in this paper refers to the formations of fairly uniform character and wide distribution that underlie the glacial drift. These formations are not made of hard rock such as one finds in many areas, but rather of soft clay shales or partially cemented or loose sands.

Bedrock waters occur in the formations of late Mesozoic or early Tertiary age such as the Cypress Hills, Ravenscrag, Whitemud, Eastend and in slightly older rocks of Belly river and Bearpaw age. The distribution of the Ravenscrag and Tertiary formations is shown on Fig. 1. The Whitemud and Eastend formations are practically confined to the same areas. So far as known at present potable water in the bedrock occurs chiefly in the western and southern parts of the province in the Belly river and younger formations.

In the central and eastern parts of the province the bedrock waters in wells that have been drilled are scanty owing to the fact that the bedrock consists almost entirely of shale to a considerable depth, or the waters have such a high mineral content that they are not used for drinking except locally by mixing them with good water.

The oldest formations that are known to carry potable water are the Belly river and the Bearpaw. In Fig. 1 the approximate eastern limit of the area in which water may be found in the Belly river and Bearpaw formations is indicated by a broken line. In the vicinity of the Canadian Pacific Railway line between Notukeu and Valmarie, at Climax and at Bracken, water can be obtained from a sand that probably is at the top of the Belly river series. At Climax this water is used but at Bracken the mineral content, consisting chiefly of sodium sulphate and sodium carbonate, is so high that the water is not considered to be usable by the town. The source for the water at this horizon probably is a long distance to the west. This seems to be indicated by the high mineral content of the water. It is probable that water can be obtained at this horizon in the area to the west of Climax but the depth of drilling in many places may involve too great an expense for individuals.

In the vicinity of Rosetown and Herschel there are a number of deep wells that yield water from the Belly river formation. At Rosetown the water is reached at a depth of 600 to 800 feet, and occurs in very fine sand. In some places shale occurs with the sand and the amount of water obtainable is very small. Screens are easily clogged because of the presence of very fine sand. The water in one of the wells rose to 9 feet from the surface and in another to 120 feet from the surface. It probably enters the sand in higher areas to the west where formations of Belly river age are exposed at the surface.

At Herschel a well drilled for oil and gas passed through an artesian water horizon at 190 feet. Beds of the Belly river series are exposed at the surface near Herschel and it is probable that the water horizon is in this series. Probably water can be obtained from the bedrock throughout the Herschel and Rosetown districts. The water, however, contains sodium carbonate and this renders it practically useless for irrigation. In the district around Mawer and north to Hanley and west to Kyle water has been found in horizons that are either in the Belly river formation or in the lower part of the Bearpaw. A detailed description of these occurrences has been given by Johnston[5] and by Maddox in reports already referred to.

Little is known as to the possibilities of obtaining water in formations of Bearpaw or Belly river age to the east of the areas mentioned. Apparently to the east the sands of these formations are replaced by shale to a great extent so that they may not be water-bearing or the water may have too great a mineral content to be potable.

A number of sand horizons occur in the formations above the Bearpaw. The Eastend formation is a fine sand which may carry water in some places, but the sand is so fine that the flow of water from it probably would be very slow. There may be some wells that get water from this horizon but they are not known to the author. In many places where the formation is present and might serve as a water-bearing horizon, younger beds that are much more porous are present and there is no need of drilling through these beds into the Eastend formation.

Sands in the Whitemud formation may carry some water in localities where they have not been changed to kaolinized sandstones. It is difficult to tell whether this formation or a similar looking sand in the Ravenscrag is the water-bearing horizon in some areas in the southwestern part of the province.

The Ravenscrag formation furnishes water of good quality in many places in the southwestern part of the province. The water is generally soft due to the presence of sodium carbonate so that it is useless for irrigation. Generally the water is found at the top of coal seams and in some places small streams issue from sands overlying coal seams. There are slight structures in the Ravenscrag and where the top of an anticline occurs there is likely to be no water. This is very good for coal mining but unfortunate for a rancher or farmer who happens to be situated on one of these structures.

Drilling in the Ravenscrag generally presents no difficulties and in most places water, if present, can be reached within 200 to 400 feet from the surface.

Stansfield[6] outlined an area in which water might be found in the bedrock as lying south and west of a line from Stoughton to Trossachs and from Trossachs to Buttress. Much of the country west of the boundary, as shown in Fig. 1, is not underlain by Ravenscrag (called Fort Union by Stansfield). The western boundary is about on a line from Assiniboia to the eastern end of Lake Johnston and extends west along the northern part of the Wood Mountain highland to north of Valmarie. In much of the country in the vicinity of Gravelbourg and along the Canadian Pacific Railway line between Assiniboia and Scotsguard there is no worthwhile water-bearing horizon in the bedrock so far as known. In the vicinity of Shaunavon and south as far as the Frenchman river and south of the Frenchman river for about twelve miles the country is underlain by Ravenscrag beds which carry water. West from Eastend and in the area covered by the Cypress Hills the Ravenscrag also contains water-bearing horizons. The Tertiary formations of the Cypress Hills also have good water-bearing beds.

Glacial Drift Waters

The finding of adequate supplies of water in the glacial drift presents a more difficult problem on account of the haphazard disposition of this material and the irregular mode of occurrence of porous horizons in it. A brief review of the mode of formation of this material is necessary in attempting to explain the various ways in which water occurs in the glacial drift.

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5 Johnston, W. A., Engineering Journal, vol. XIV, No. 1, pp. 28-31, 1931.

6 Stansfield, J., Geol. Surv. Canada, Summ. Rept. 1917, pt. B., pp. 41-52 (1918).

Previous to the advance of the Pleistocene ice sheets over Saskatchewan the country on the whole probably had little relief except for flat top highlands in the areas now occupied by the Missouri Coteau, Moose Mountain, Cypress Hills and other highlands. There were undoubtedly many stream valleys and some badlands along the sides of these highlands. Very likely these stream beds were filled in part with gravel and sand. When the ice sheet advanced these gravels and sands were either eroded or were buried beneath glacial drift and new gravels were laid down by glacial streams in valleys that existed at that time. During at least two interglacial stages probably new valleys were made and more stream gravel and sand deposited. Thus in a number of localities there are buried stream beds of a dendritic or tree-like pattern heading in the highland areas. Such buried stream beds heading in the more or less porous morainic areas of the highlands concentrate the ground water of a wide area into a rather confined space and give rise to artesian water supplies in the drift. A number of such occurrences of water are found along the south side of the Missouri Coteau and in other areas. The one that is best known is the Boggy Creek area that furnishes a part of the water supply for Regina. An area in the vicinity of Rouleau is somewhat similar to the Regina area. The gravel and sand from which the water comes is buried beneath impervious clay and is practically on top of the bedrock. Some reaction of the salts in the water with the minerals in the shale or drift has caused this water to be fairly soft which is very unusual for water occurring in glacial drift in the province. In the vicinity of Rouleau the water seems to be confined in a bed of gravel and sand not over a mile wide extending in a northeast and southwest direction with the centre a little east of the town. Places to the east and to the west of this old stream bed can only get a very limited supply of poor quality water in the boulder clay. Whether this water comes from the north or from the north slope of the Missouri Coteau to the south is uncertain. The facts that north of Rouleau more water-bearing gravels occur and that the mineral content of the water decreases to the north from 2,000 parts per million to 1,700 parts per million seems to indicate a source to the north. No accurate series of elevations of the wells have been made so that the slope of the water-bearing horizon is not known.

Locating of buried stream-bed types of artesian water is difficult because of the irregular pattern which the beds may have. In some areas the channels are very close to the sites of the present valleys leading from the higher morainic belts. The Mound Spring and Boggy Creek areas that furnish water for Regina are examples of this type. In places cold springs may indicate that the water is coming from an artesian basin of this character. Such artesian sources might be located by electrical methods after a geological study of the locality had been made, but the cost of such a survey by a reliable method is high.

Another type of ground water supply associated with the glacial deposits is that found in places where outwash sand and gravel occur at the surface. The sand and gravel allow the water to penetrate deep enough to prevent large losses by evaporation, so that a large part of the rainfall of an area underlain by these deposits may be stored underground. Usually, however, the areas are not very large and the supply of water found in outwash sands and gravel is not great, but the quality as a rule is very good. The town of Melville gets most of its supply from a broad belt of outwash sand and gravel north and northwest of the town. The water table is only ten or fifteen feet from the surface and the water is obtained by means of a collecting gallery. Part of the supply used by Moose Jaw comes from the Sandy Creek area and is of a similar nature except that the sand and clay probably were deposited in a glacial lake.

Another type of supply is found where glacial outwash sand and gravel underlie clay. The Yorkton supply appears to be of this type. The water is not under pressure and apparently the sand and gravel act simply as an underground reservoir; as the supply is used the water level drops and unless the source is replenished at the same rate at which it is used, in time such a supply may become practically exhausted.

In the material that forms the valley bottoms of the present stream valleys there are in places porous horizons of sand and gravels which may yield a fair supply of water. These water-bearing beds may be largely post-glacial in age but there are some also that are Pleistocene or Glacial in age. In many places considerable sediment has been deposited even since the coming of white men to the country, as is shown by the remains of horses and cattle buried under twenty to thirty feet of alluvium in some small stream valleys. The Qu'Appelle valley is an example of a valley with a thick bed of alluvium and drift. Near Lumsden in this valley a well passed through two hundred feet of sediments above the bedrock.

Summary and Conclusions

In drilling for water in southern Saskatchewan a knowledge of the geology is useful. Areas where water may be obtained from the bedrock are mostly in the western and southern parts of the province. Bedrock formations from which potable water may be obtained are the Belly River, Bearpaw, Whitemud, Ravenscrag and Tertiary (Cypress Hills beds, etc.). The water in the Belly River and Bearpaw formations is generally much mineralized and the farther east it is found the greater is the mineral content. Artesian water also occurs at places in the glacial drift. More work is necessary to determine the extent of the artesian areas and the amount of water available. As a result of such work proper methods of conservation could be developed.

Mineral Character of the Underground Waters in Southern Saskatchewan

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY—The artesian waters of southern Saskatchewan, except those that come from a considerable depth, are generally usable for drinking purposes, although they contain a fairly high proportion of soluble salts. The deep well waters that come from below the Belly river beds, so far as known, are saline. The artesian waters, as a rule, contain so much of the salts of sodium, especially the carbonate, that they are not well adapted for irrigation purposes under the conditions of precipitation, evaporation, topography and soil found in southern Saskatchewan. The waters from the shallow wells in the sandy beds of the surface deposits or glacial drift overlying the bedrock, as a rule, contain smaller amounts of soluble salts and are the most satisfactory for drinking purposes. Improvement of the artesian waters by mixture with other types of water, with possibly chemical treatment, is a problem that requires investigation.

Relation Between Chemical Composition and the Principal Uses of the Underground Waters

For human consumption water must not have so high a content of dissolved salts as to render it unpalatable or injurious to health. The temperature of a water high in sodium salts has a marked influence on the taste of the water. In some of the artesian areas of southern Saskatchewan water containing up to 1,500 or even 2,000 parts per million of sodium salts is quite palatable if drunk at the temperature at which it issues from the well—45 degrees to 48 degrees F. Such water, however, if allowed to warm up in a city supply system would have a decidedly flat "soda" taste. If the water contains a large proportion of the sulphates of sodium and magnesium it may be too laxative for constant use although within reasonable limits the continued use of the more laxative waters appears to build up a certain degree of resistance.

Many waters, especially the highly saline water often found in shallow wells in the "drift" (this term being used in this paper to include all types of glacial and post-glacial deposits) that are not considered fit for human consumption, are used for stock. It is generally considered that waters containing fairly large amounts of dissolved salts may be used for stock. Should the water be so bitter, however, due to the presence of magnesium sulphate, or should it cause scouring, due to the sulphates of sodium and magnesium, it becomes unusable for stock. The presence of common salt in most of the artesian waters obviates the use of salt licks for cattle and the mildly laxative action of the sodium and magnesium sulphates is of value during the winter months when dry foods such as hay are used. High sulphate content of water has been considered to be the cause of degeneration of the bones of cattle by abstraction of lime, but this is doubtful and further research on the question is needed.

For irrigation purposes in an area of such small rainfall as southern Saskatchewan water should not contain a high proportion of dissolved salts. The safe upper limit varies with the nature of the salts, the soil, drainage conditions and the crop. It is generally considered to be about 700 parts per million but in exceptional cases it is 1,000 parts per million. In Australia 700 parts per million of alkaline salts are considered to be the upper limit. Most of the artesian waters of southern Saskatchewan far exceed these limits. In the Sahara, however, water containing up to 8,000 parts per million of solids, about half of which is sodium chloride, has been used for irrigation under special conditions. The toxicity of the sodium salts to plants varies in the approximate proportion of 10:5:1 for the carbonate, chloride and sulphate respectively; of these the carbonate forms the dreaded black alkali, the chlorides and sulphates white alkali. In the Central Butte district in south central Saskatchewan, the singular spectacle was seen of a farmer, in a very dry year, suing the owner of a flowing well because water from that well was flowing through his farm.

For laundry purposes the water from the drift is almost invariably too hard. Many of the artesian wells yield waters that are soft but contain a good deal of sodium carbonate. For use in boilers the generally high content of calcium sulphate in the drift waters renders them likely to cause hard scale. The soft artesian water is likely to cause foaming. A well at Mawer Station in the Darmody-Mawer artesian basin has a large flow but the water is not used for boiler purposes. It is reported, however, that the water causes foaming only when mixed with hard, drift water. The corrosive action of water is important in the case of waters used for municipal purposes. It would seem probable that the artesian waters would be corrosive.

Special Conditions Affecting the Chemical Composition of the Underground Waters

The small rainfall, the absence in much of the area of through drainage to the sea, the generally flat topography and the presence of many undrained hollows due to uneven deposition of the glacial drift, all tend to prevent the removal from the soil and subsoil of mineral salts and favour the rise of salts to the surface by capillarity and deposition of salts from spring waters. The extreme limit of concentration of salts is the alkali-lake deposit but many of the waters from wells in the drift contain a high proportion of salts. It is evident therefore that the drift contains a great deal of salts and the presence of numerous crystals of selenite-calcium sulphate at many outcrops of the Cretaceous shales shows that these rocks also contain salts.

The chief dissolved salts that have marked influence on the uses of the underground waters are the sulphates, chlorides, and carbonates of sodium, calcium and magnesium.

Sodium sulphate or Glauber's salts is a mild laxative, the dose for this purpose being one half to one ounce of the hydrated salt. It is the least harmful of the common salts when present in waters used for irrigation.

Sodium chloride or common salt in moderate amounts has little action on the body functions. In quantities of over 500 parts per million it gives a brackish taste to water and at high concentrations it produces a water that will not quench thirst. In water used for irrigation it is intermediate in toxicity between the sulphates and carbonates.

Sodium carbonate, which in the artesian waters seems to occur always as the bicarbonate, has no harmful effect on humans if used in moderate amounts. If present in the water used for irrigation, however, it is the most harmful of the sodium salts, the safe limit for this purpose being about 100 to 200 parts per million of the normal carbonate. Calcium and magnesium carbonates and bicarbonates give temporary hardness to water. They were for a long time considered to cause gall stones and other troubles but are now thought to be quite harmless in this respect. They are more abundant in waters from the drift than in those

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from the older rocks. In water used for irrigation they are much less harmful than the sodium salts.

Calcium sulphate in moderate amount in drinking water is not so harmful as the sodium salts. Waters with very high calcium sulphate content occur in regions in which gypsum is found and are used for human consumption. Unless present in very large amounts it is not harmful for irrigation purposes; gypsum is often added to the soil to counteract the effect of sodium carbonate by converting it to the less harmful sodium sulphate.

Magnesium sulphate is a slightly stronger laxative than sodium sulphate, the dose for human use for this purpose being ¼ to ½ ounce of the hydrous salt. It is much more harmful to the system than sodium sulphate, however. In the artesian waters that come from the bedrock it is generally quite subordinate to the sodium salts but in the waters from the drift it is much more prominent although usually being less in amount than the calcium sulphate. In water for irrigation it appears to be less harmful than sodium carbonate.

As regards taste imparted to water by the dissolved salts, calcium sulphate and calcium and magnesium carbonates are practically tasteless. Sodium sulphate in small amounts is nearly tasteless, sodium bicarbonate gives a "soda" taste to the water and magnesium sulphate in large amounts gives a bitter taste.

Chemical Classification of the Main Types of the Underground Waters

The waters from wells in the drift show great variation in the amount and composition of salts even within short distances. They may perhaps be roughly classified into those that are derived from the more argillaceous type of deposits—boulder clay, lake clays, etc.—and those derived from the more sandy types of deposits, outwash sands, dune sands, etc. In the former type the salts are seldom less than 1,000 parts per million and are often several times this figure. The composition of the salts varies widely, but in general calcium and magnesium sulphates are the chief salts, with sodium chloride subordinate and sodium sulphate and carbonate variable. Calcium and magnesium carbonate are generally present but are usually subordinate to the corresponding sulphates. These waters are very hard and many of them are not well adapted to irrigation even were they found in sufficient quantities for this purpose. The water from the sandy type of drift in places is very hard and is high in salts, but in very sandy areas it is likely to be less hard than the previous type, some waters from very sandy areas being even reported as soft. Some of the waters from shallow wells or collecting galleries in the sandy areas contain only 600 to 700 parts per million of soluble salts and are the best underground waters so far found.

The waters from wells in the Tertiary and Cretaceous rocks, with a few exceptions, show less wide variation in salt content than do the drift waters and are generally not so hard. Two general types are very common, at least in the Rush Lake and Elbow quadrangles and in parts of the Regina and Touchwood quadrangles. The sodium sulphate-carbonate-chloride type may be regarded as the "soft normal" type and water containing these salts with calcium and magnesium sulphate in addition may be referred to as the "hard normal" type. The sodium chloride type is comparatively rare but the waters frequently contain large amounts of this salt, 10,680 parts per million being reported in one well, and are commonly found at considerable depths in the bedrock, for example in the deep wells at Moose Jaw and Simpson. Many intermediate types between the above mentioned ones are found. Many of the waters are absolutely soft. The salt content varies but most of the analyses available show 1,250 to 2,500 parts per million.

Waters of Artesian Areas

The Carnduff area in the southeastern corner of the province, described in Memoir 174, Bureau of Economic Geology, pages 13-14, covers about 400 square miles over most of which area flowing wells are found. Analysis of water from Cornduff creamery, close to the limit of water flow, shows a very unusual combination of sodium and magnesium carbonates with sodium chloride, total solids being 1,044 parts per million.

The Darmody-Riverhurst area described in Summary Report, Geological Survey, Canada, 1931, Part B, pages 58-71, covers at least 500 square miles. It is one of the most clearly defined artesian basins in Saskatchewan that have been studied to date. The underground surface of the water is generally at a very uniform level and analyses show that the water is very uniform in salt content—1,250 to 1,650 parts per million. With the exception of a few wells, considered as marginal, the water is all of the "soft normal" type. Flowing wells are obtained in the eastern part of the artesian basin.

Twelve detailed analyses show that the average quantity of salts in solution in the water is 1,615 parts per million, almost entirely consisting of sodium chloride, sodium carbonate (probably existing as the bicarbonate) and sodium sulphate in the approximate proportion of 1:3:4 respectively.

The sources or intake beds of the water are not definitely known, but it is possible that the water enters the basin in sandy beds in the valley of Swift Current creek, 60 miles to the southwest.

In the east half of the Elbow quadrangle, described in Summary Report, Geological Survey of Canada, 1932, part B, pages 75-89, the ground water is much less uniform in amount and composition of salts, than in the Darmody-Riverhurst area. In the southern and central parts of the quadrangle, including the Brightwater Creek area of artesian water flow, most of the water is of the "soft normal" type but the total solids are generally about 50 per cent higher than in the Darmody-Riverhurst area. In the northern part of the quadrangle a flowing artesian area occurs in which the water is of the "hard normal" type.

An artesian area in the western half of the Rush Lake quadrangle described in Summary Report, Geological Survey of Canada, 1932, part B, pages 76-79, has water of the "soft normal" and "hard normal" types. South of Beechy, two small flowing artesian areas occur; in one the water is the "soft normal" type and in the other the water is very hard.

Several artesian areas, found in the vicinity of Regina, are described in Geological Survey of Canada Summary Report 1929, part B. The most important of these areas are the valley of Boggy creek, Mallory Springs valley and Flying Creek basin. The water occurs in sandy beds in the drift and is hard. An analysis of the Boggy creek water, the chief source of supply, shows total solids 995 parts per million, the sodium salts being 115 parts per million and sodium carbonate 101 parts per million. Analyses of well water from the Mound Spring area and from the Mound, Cooper and Dickson springs show a wide variation but they all show the water to be hard. The sodium salts vary from 201 to 449 parts per million, sodium carbonate being reported only in the Mound Spring.

The underground water conditions near the city of Moose Jaw are described in Geological Survey of Canada Summary Report 1930, part B, pages 50-64. The sources of supply are Snowdy Springs, Sandy Creek gallery, the Forsythe well and the Sandy Creek well. The first three contain 486 to 686 parts per million of total solids in solution, with sodium from nil to 98 parts per million, and are hard. The last named is much higher in total solids—1,218 parts per million. The Sandy Creek well water is only moderately hard—186 parts per million. The difference between the shallow water in sandy beds, near the surface and that obtained at even so small a depth as 80 feet is well shown by a comparison of analyses of the water from Sandy Creek gallery and from No. 1 well at Sandy Creek. Total solids in the former are 486 parts per million and in the latter 1,218 parts per million. Analyses show the water from Sandy Creek gallery to be the best so far found in the Regina and Moose Jaw districts, both for drinking and irrigation purposes.

Mode of Origin of the Soft Artesian Waters

The softness of the water in the Darmody-Mawer artesian basin may be due to base exchange of calcium to sodium by minerals of the glauconite type in the water sand. Glauconite[1] is known to occur in Cretaceous sandstones at places in the prairie provinces. A solution of calcium sulphate left for twenty months in contact with Cretaceous sand that occurs in the valley of Swift Current creek and may form part of the intake beds for the artesian water, showed a marked softening. Bentonite as well as glauconite is known to be capable of softening water by the base exchange process. Bentonite[2] bands are of frequent occurrence in the Cretaceous shales and it is probable that a good deal of bentonite is distributed through the Cretaceous strata and through the glacial drift which is largely derived from these beds. Water softening therefore may have occurred also as a result of the base exchange properties of bentonite.

Possibilities of Improving the Character of the Well Waters

Fairly large quantities of artesian water, sufficient for the irrigation of farm gardens, are available in the Darmody-Mawer basin and in other areas but these waters are so high in sodium that they cannot be used for this purpose. They are also unsatisfactory for drinking. Whether these soft, sodium waters can be altered by some simple and inexpensive method so as to render them suitable for irrigation and other purposes; and whether their mineral character would be improved by mixing them with hard waters are problems that require investigation.

1 Glauconite—a naturally occurring mineral from which zeolites are prepared as used for water softening.

2 Bentonite—a type of china clay used for filters and as filtration agents.

Rural Water Supply in Alberta

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Paper presented before the Edmonton Branch of The Engineering Institute of Canada, March 14th, 1934.

To the average city or town dweller, water requirements rarely present any worries, as his needs are efficiently catered for even to the extent of the water being chlorinated to remove dangerous contamination. Should, however, the supply at the tap fail, he has only to communicate with the district water department and it is not long before the service is again available—that is always provided the service has not been deliberately cut off on account of the non-payment of a water bill.

The rural dweller, however, has seldom a benevolent water board to serve his needs, which must be supplied by his own efforts. Failing a convenient surface source, his supplies are obtained from underground deposits by wells from which the water has to be lifted by either mechanical means or manual labour. A rural supply of water is not usually available under any co-operative scheme, as distances between source and consumption points are so great that this would necessitate prohibitive capital expenditure. It is however a barren, waterless country where the requirements of a household cannot be obtained at a comparatively shallow depth by means of dug wells.

The sinking of these wells is done by manual labour, in the majority of cases by persons with little or no experience in this class of work. As a result the protection of well walls is often inadequate and the material used is poor, resulting not only in the need for frequent repairs and the cleaning out of silt, but also in pollution of the underground supply by the seepage downward of surface water carrying detrimental and even insanitary material. These wells are seldom located where water contamination would be minimized, the selection usually being one of convenience irrespective of the risk of contamination from house garbage dumps, cattle sheds or domestic conveniences, from all of which there occurs continuous soakage. Such contamination can be considerably minimized if the well neck is made of brick, concrete, or stone masonry carried well above the surrounding surface and extending downwards below any sub-surface beds through which polluted surface soakage can easily flow.

To be of long usefulness, dug wells should have a masonry lining for the full depth, but this is expensive as such work has to be done by well sinkers. Here in Alberta such experienced labour is not available except at extraordinary wages to which must be added the excessive cost of the material for the lining. Therefore, it is correct to assume that these costs are beyond the means of the majority of rural dwellers here, resulting in their supplies of water having to be obtained in most cases from wells, the sides of which are inadequately protected by softwood linings which not only soon deteriorate but never effectually shut off polluted water inflow.

An advance on hand-dug methods is the drilled well, sometimes sunk by manual or horse power but more frequently by mechanical means. These wells being of small diameter, are cased with metal pipes extending from the surface downwards for approximately the full depth to the water horizon and, if properly completed, would prove a permanent asset. Unfortunately, it is seldom that such wells would be passed by an engineer, since for reasons of economy, the pipe is usually cut off flush at the surface and, further, none of the pipes used are ever cemented for soakage exclusion purposes, nature apparently being expected to carry out this—one of the most important details in the construction of a drilled well.

It is well known that in many parts of Alberta the immediate sub-surface water carries considerable quantities of alkali, rendering the water unpalatable for drinking, and in most cases, unsuitable for cooking. Usually below such unpleasant sub-surface water horizons, comparatively good water can be met at lower depths, with the result that well sinkers and drillers frequently dig to these deeper sources of supply and in doing so, on account of their inexperience, they permit the non-potable sub-surface water to pass downward and mingle with the lower water, thereby altering the latter to the same unsatisfactory condition in a very short time.

Confirming such unintentional pollution and underground wastage of surface water, there are many places in Alberta and other parts of the prairie provinces, where sloughs or small lakes have completely dried up within recent years. Frequently, close to such dried out areas, there are to be found dug wells of varying depth and these may have served as the channels whereby the surface water escaped underground.

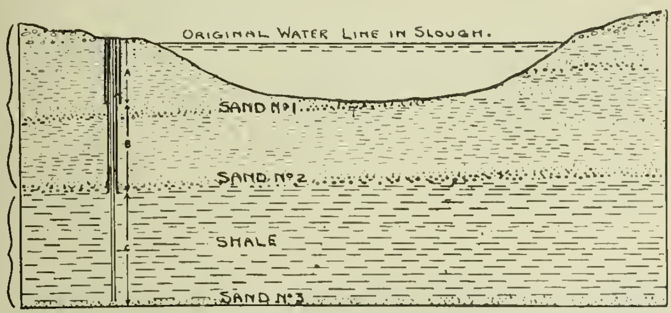

Fig. 1

An example of the presumed downward water seepage is shown in Fig. 1. The initial hand-dug well is represented at *A*, the wall sides being usually protected by a wood lining. On the water from the No. 1 horizon becoming unsatisfactory for use further deepening is carried out as at *B;* this being done either by hand work or by bucket auger operated by horse power, the well sides again being protected by wood in the form of circular cribbing usually built up and lowered from the surface.

On the quality of the second water stratum changing, the well is in the majority of cases abandoned without being filled in. This not only permits the continuous downward passage of water from the slough and any water horizons that may have been passed through, but also presents a continuing danger to persons and livestock. In a few cases deepening may be continued either by bucket auger or drilling machine and metal well casing inserted so as to permit the elevation of the water by manual, wind power or mechanically operated pump.

The further deepening and the use of metal casing is a correct procedure and would be permanently satisfactory if the casing is properly cemented and the depths *A* and *B* filled in with rubble and mud slurry. Unfortunately few, if any, water well drilling contractors have experience in well cementing and lack the necessary pumping and other equipment essential for such work. They are, therefore, obliged to rely on undesirable water being excluded by debris from the clay or shale formation settling around the inserted pipe. Owing to bored and drilled wells not always being truly vertical and frequently more elliptical than circular; both of which defects may happen on account of the varying hardness of the formation drilled, the settlement of debris and formation on the casing cannot be uniform and voids must remain, down which there always occurs a flow of water thereby causing ever-increasing channelling.

Thus many of these faulty wells are serving as channels by which horizons of good potable water are rendered unusable. That the use of well-drilling machines for water supply will be considerably extended in the near future needs no emphasizing, and there is an immediate and imperative need of efficient control to ensure that contamination is not allowed to continue, otherwise all good water horizons underlying Alberta may, in a few years, be rendered unsatisfactory for use.

In Alberta it would be interesting to see the results of prolonged controlled tests of underground water levels made at different points in the province. In all probability it would be found that the sub-surface water table is dropping rapidly—in fact it is very possible that in some areas the top water horizons may be found to have disappeared completely and required supplies of water have to be searched for at greater depth.

From the findings obtained in the drilling of deep wells in the south and midnorth of the province, there is ample proof that several prolific horizons of good water are to be found down to 1,000 feet from the surface and it is, therefore, safe to forecast that there is no immediate fear of a water famine in the areas above cited, provided means are available for reaching the water and lifting it to the surface. Below 1,000 feet the chances of good potable water being found are speculative, as most deep horizons carry a considerable mineral content which precludes the use of the water for human or animal consumption.

At present all over the North American continent great stress is being laid on the conservation of natural resources, and, water being an absolute necessity for sustaining life, must be classed as the most valuable of these. How seldom do we hear any call for its conservation and protection. As already noted, any tyro is allowed to sink wells and thereby not only permitted to pollute underground water sources but also drain surface deposits, thus apparently interfering with the work of nature in augmenting supplies by rainfall. The author believes that government interference in private effort should be the least possible, provided individuals are efficient in their enterprises, but where waste is rampant it appears imperative that governments should control the selfish and incompetent. It is, therefore, considered that the search for and development of potable water should be under some form of supervision which will control all sources of contamination, and in a measure discipline those carrying out the engineering work to insure its being carried out efficiently.

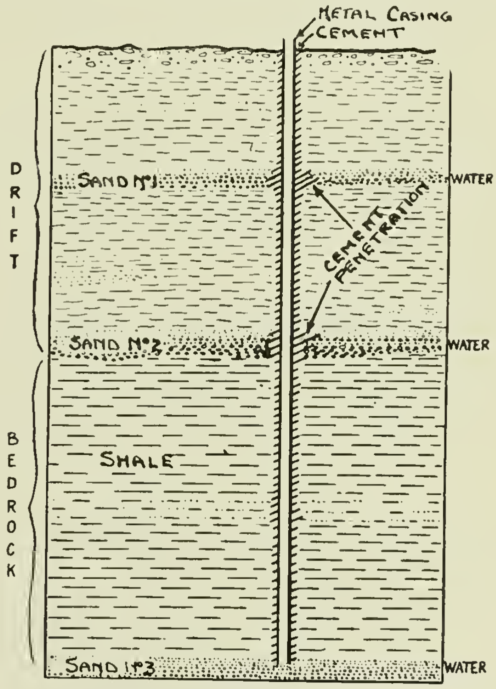

Fig. 2—Section of Drilled Well Showing Cement Protection.

This last requirement would require the registration of all contractors and others engaged in the digging or drilling of water wells, and that no well should be commenced without the specification of the projected work being first scrutinized and authorized by a recognized body. With such control the construction of all wells would be regulated—the necks of dug wells would be protected by proper linings carried above the surface and below the sub-surface porous strata to prevent pollution. In deeper wells where pipe is used all unsatisfactory water would be shut off by cementation or such method as would insure a lining behind such pipe which would prevent undesirable infiltration even should the metal of the pipe entirely disappear through corrosion.

The suggestion will perhaps appear premature and too advanced for these times but inasmuch as water in many places at this moment is at a premium on account of its scarcity, all rights to underground water should be reserved to the Crown. In the author's opinion no natural resources below the surface should ever be placed under the control of individuals who may permit their dissipation to the detriment of the public interests.

The author wishes to state that he is not a specialist in ground water problems and in presenting this paper has done so solely to make known personal observations of what is apparently one of the serious dangers likely to interfere with the prosperity of the prairie provinces; also to create in young engineers an interest in drilled well contracting, a class of work which has been somewhat neglected in the past by the trained engineer.

Relationship of Geology to Soil Drifting in Southern Manitoba and Southern Saskatchewan

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY—Dry farming methods and single crop farming, together with the prevalence of high winds in times of drought, and general absence of wind breaks, are the chief causes of soil drifting. In the present paper the character, extent and mode of origin of the materials on which the soils are developed in Manitoba and Saskatchewan south of latitude 52 degrees, are discussed in relation to the question of soil drifting.

Soil drifting in the Prairie Provinces began after the period of intensive settlement, from 1906 to 1910, and has gradually increased since that time but has been most pronounced in times of drought. Previous to this period there were, however, in the drier southern and southwestern parts of Saskatchewan large areas of "burn-out" where the surface soil had been removed in patches probably in part by wind action.

Dry farming methods and single crop farming, which demand excessive cultivation of the soil, together with the occurrence of high winds in times of drought and the general absence of wind breaks are the chief causes of soil drifting. The causes have been well discussed in the Soil Survey publications of the University of Saskatchewan and it has frequently been pointed out in these publications that the permanent solution of the problem is to be sought in the adoption of systematic crop rotations, though much can be done by careful management of the soil, by the use of protective crops and by strip farming, that is, farming of the land in narrow strips, cultivated cross-wise to the direction of the prevailing winds. There are, however, large areas where sufficient water for live stock farming may not be obtainable, so that in these areas the problem is a difficult one. The planting of hedges to act as wind breaks and to collect snow, and the storage of spring run-off water for farming and municipal purposes has been advocated by T. C. Main (Engineering Journal, June 1932).

As some parts of the region are much more affected by soil drifting than other parts it may be of value to discuss briefly the character, extent and mode of origin of the materials on which the various soils of the region are developed. Map 254A published by the Department of Mines, Ottawa, shows the general character of the surface deposits of Manitoba south of latitude 52 degrees and of a small part of eastern Saskatchewan. The Regina sheet in course of preparation describes the surface deposits of Saskatchewan south of latitude 52 degrees. Both maps are on the scale of 8 miles to the inch.

*Published with the permission of the Director, Bureau of Economic Geology, Department of Mines, Ottawa.

Dune Sand Areas

In Manitoba dune sands occupy 1,250 square miles of a total area of 43,380 square miles that has been mapped. The largest single area, much of which is included in the Spruce Woods forest reserve, extends along the Assiniboine river for fifty miles east from near Brandon. There are other fairly large areas south of Portage la Prairie and in the Souris valley near Hartney and Oak lake. Live dunes occur at places in the dune areas, but for the most part the surface has a protective covering of vegetation and there is comparatively little soil drifting except locally. The occurrence of remains of an extinct bison at a depth of only a few feet in dune sand near Douglas shows that some of the dunes are very old. There are few occurrences of buried soils and it seems probable that the dunes have not been active to any great extent since they first became clothed with vegetation several thousand years ago.

Around the margins of the sand dune areas and in places in the Souris valley, that was once a lake bed, there are areas of dune silt and very fine sand. This material somewhat resembles loess but differs from true loess in that it is not compacted or cemented and is very easily eroded. These soils drift badly once the protective sod is destroyed by cultivation, but the areas are comparatively small.

In southern Saskatchewan the largest tract of dune sand, covering an area of approximately 1,500 square miles and known as the Great Sand Hills, lies north of the Canadian Pacific railway between Maple Creek and Swift Current and extends north nearly to Lancer on the Empress branch of the Canadian Pacific railway. Only about 20 square miles of the area are included in the Seward forest reserve as the region has little forest growth. In the vicinity of the elbow of the South Saskatchewan river a dune area of about 100 square miles is included in forest reserves. Another tract of about the same extent lies on the east side of the South Saskatchewan river, south of Saskatoon and is included for the most part in the Dundurn forest reserve. Many smaller tracts occur throughout the region except in the extreme south.

In the Great Sand Hills there are many live dunes that appear to have developed in recent years, and some damage to adjacent farm lands has been done by drifting of the sand, but the greater part of the dune area is protected from drifting by vegetation. Around the margins of the dune areas and particularly on the south and east sides there is a belt a few miles wide of very fine sand and silt that has been deposited from the air. These areas drift badly after a few years cultivation.

Considered as a whole the sand dune areas do not enter largely into the problem of soil drifting at the present time as they have been cultivated to only a slight extent and are not drifting except locally. The dune areas of very fine sand and silt require protective measures to prevent soil drifting, but are of no great extent.

Lake and Alluvial Clay Areas

In Manitoba and adjacent parts of Saskatchewan stoneless clay areas that were once lake beds cover nearly 5,000 square miles, the largest single area being in the Red River valley and along the lower part of the Assiniboine river.

In southern Saskatchewan lake clay forms the Regina plain, extending northwest from near Weyburn to Moose Jaw and south from Qu'Appelle valley nearly to Avonlea. Another large area lies on the west side of the South Saskatchewan river and extends from Outlook north nearly to Saskatoon and west to Rosetown. In the south there is a fairly large area in the vicinity of Gravelbourg and in the west scattered areas to the east of the Great Sand Hills. The total area is approximately 6,120 square miles.

These clay areas are generally considered as forming the best farm lands. They are affected by soil drifting to some extent, particularly in the southern drier parts of the provinces and where the soils have been cultivated longest. The very factors which render the soils easily cultivated and highly productive, namely their finely-granular texture due to the high organic matter content in the form of humus and the calcareous character of the soils, also render them easily affected by soil drifting. Small rounded clay grains, which at first glance appear to be sand grains, drift before the wind, fill ditches and accumulate along fences and other barriers. Drifting of the black clay soil of the Red River valley is well shown near Morris and at other places in southern Manitoba; and of the Regina brown clay soil at many places along the highway east of Regina and between Regina and Moose Jaw. Soil drifting in the lake clay areas is not so serious as might be supposed, for it occurs chiefly in times of drought and the great depth of the humus soil prevents exposure of the subsoil. There is no question, however, that soil drifting in the lake clay areas has increased during the past few years and in time will demand remedial measures for its prevention.

Lake Sand and Silt Areas

Areas of sandy and silty soils in Manitoba occur around the margins of the lake clay areas and are widespread in the ancient delta of the Assiniboine river extending from Brandon to Portage la Prairie and in the Souris valley. They cover an area of 8,340 square miles.

In southern Saskatchewan similar surface materials occupy areas in the former lake beds along the Qu'Appelle and South Saskatchewan rivers. They are widespread in the Rosetown district near Mortlach, west of Moose Jaw, around the borders of the Great Sand Hills, and in the vicinity of Saskatoon. Altogether there are about 1,800 square miles of sand and silt deposits in southern Saskatchewan.

These areas are easily affected by soil drifting because of the loose friable nature of the soils. On account of their character and extent they particularly demand remedial measures for the prevention of soil drifting. In Manitoba only parts of these areas are affected particularly in the Souris valley and in the Assiniboine delta region, whereas in Saskatchewan nearly all the areas are affected.

Boulder Clay Areas

In southern Manitoba soils developed on boulder clay or glacial till are the most widespread and are only slightly affected by soil drifting. The few areas that are affected lie in the drier southwestern part of the province.

In southern Saskatchewan the boulder clay areas are also the most extensive and are affected by soil drifting particularly in the drier southern part of the province and where the boulder clay has a thin covering of sand. Boulder clay forms the surface materials over all the region except in the former lake beds, in comparatively small areas where glacial sands and gravels occur, and in parts of the Wood Mountain region where there is practically no glacial drift. The boulder clay varies in composition to some extent according to the type of local material from which it has been derived. In places where there are extensive sand formations underlying the drift or where older glacial outwash deposits have been reworked the boulder clay is very sandy. It is in this type of deposit that drifting does the most damage, for generally there is nothing but a cobble pavement left at the surface after the top soil has been blown out. Such areas may be observed in the vicinity of Aneroid and near the Moose Jaw reservoir at Snowdy Springs. There are between 65,000 and 70,000 square miles of boulder clay area in southern Saskatchewan and about a quarter of this is the rolling moraine type of country. The outstanding moraine areas are the Missouri Coteau, Moose Mountain, Touchwood Hills and Allen Hills. The moraine areas are not cultivated extensively and have not been affected by drifting except very locally. Large parts of the more even ground moraine type of country particularly in the region south of the Qu'Appelle and South Saskatchewan river valleys are affected by soil drifting, but in places also to the north of these valleys.

"Burn-out" Areas

Areas in southern and southwestern Saskatchewan where the surface of the ground is characterized by shallow depressions having little or no humus soil and containing in many places accumulations of soluble salts are known locally as "burn-outs" or "blow-outs." They occur in the drier southern and southwestern parts of the province, chiefly in boulder clay tracts that have a thin covering of fine sand and silt deposited from the air. The depressions are a few inches deep, and are roughly circular or oval in shape, varying from a few feet to twenty or thirty feet or even more across; and as the bare subsoil is exposed and there are accumulations of salts, chiefly sulphates of sodium and magnesium, in them, they are not productive under cultivation except in very favourable seasons.

Development of the "burn-outs" appears to have antedated the period of intensive settlement judging from the accounts of early settlers who state that after ranching began in the region and measures were taken to prevent the spread of prairie fires, the result of protection from fires was that the soil became covered with a thick mat of prairie grasses and when fires did occur the surface soil in places was destroyed. During the past thirty years, however, there have been comparatively few prairie fires and the "burn-out" areas appear to have remained in about the same condition or to have been extended. Similar soils occur in semi-arid regions in other parts of the world and are known as saline, white alkali or solontshak soils. It is possible that prairie fires may have had something to do with the formation of the depressions but the main factors probably are the dry climatic conditions, the effects of high winds, and the character of the materials on which the soils are developed.

The "burn-out" areas occur chiefly in two regions, in a belt ten to twenty miles wide along the International boundary and extending for one hundred miles east of the Alberta boundary; and in a belt about ten miles wide between Avonlea and Estevan in south-central Saskatchewan. Farming of these areas has been attempted at many places but with no great success. Owing to the unusual soil conditions the areas present special problems not entirely connected with soil drifting.

Tree Planting in Relation to Drought Control

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

The present situation in many large areas of the prairie provinces, brought about by successive seasons of drought, is a most serious one. Much concern is being felt regarding the future, should similar conditions recur, as past history would indicate to be almost a certainty.

Drought conditions, coupled with the common practice of bare summer-fallowing of immense acreages with repeated cultivation of the soil, has so depleted the natural fibre and humus that soil drifting has become a serious menace. It is doubtful whether soil drifting in these areas can now be controlled, even in seasons of normal precipitation, unless some radical change is made in cereal farming methods.

The daily press, farm papers and even popular magazines have been carrying numerous articles dealing with the situation which is recognized as a national calamity, calling upon governments to do something about it.

Suggestions to counteract the effect of drought have been freely offered, often by those not sufficiently conversant with the practical problems involved, advocating schemes of a wholesale nature the carrying out of which would involve enormous expenditures, and setting forth extravagant claims as to the benefits which would result. Most of these suggestions have included wholesale planting of trees, with the claim that by so doing rainfall would be increased and the climate changed. Unfortunately such claims are not justified by available data and immediately invite adverse criticism. This is most unfortunate, for in the resulting controversy, the very great economic benefits which might follow the systematic establishment of practical shelter belts are sidetracked and more or less overlooked.

For the benefit of those not familiar with prairie conditions the problems of tree planting in these areas may be briefly considered. In passing, the author may mention that the facts submitted and the opinions expressed are based on over thirty-seven years actual residence in Manitoba and Saskatchewan, the last thirty-four of which have been spent in supervising a scheme which has for its object the establishment of plantations on prairie farms.

During this period one hundred and thirty-nine and a quarter millions of seedlings and cuttings have been sent out from the Dominion Forest Nursery Stations into the three prairie provinces, distributed amongst approximately fifty-four thousand farmers. Over fifty per cent of these are in Saskatchewan. Some failures have naturally occurred but are only a small proportion of the whole.

On account of a minimum of precipitation and extremes in temperature certain methods in establishing plantations must be followed out. One cannot, as in the east, just go ahead and dig holes in the ground, plant the trees and then leave them to become established. Before planting the soil must be carefully prepared, to eradicate native perennial grasses and weeds and also to store up a reserve of moisture to give the new plantings a reasonable start. After planting the belts must be given systematic cultivation to conserve the very limited supply of moisture and prevent the growth of grass and herbaceous weeds which would compete with the trees for such little moisture as is available. Then a wise choice of varieties must be made, using only such kinds as experience has shown to be hardy and capable of standing up under prolonged periods of drought. Unfortunately choice is thus limited to a very narrow list and in dealing with the areas most subject to drought the selection is practically confined to three varieties of broad leaf species, namely, caragana, ash and elm and a few varieties of hardy spruce and pine. This does not mean that there are not other kinds of trees and shrubs hardy enough to withstand severe conditions, but availability of seed and comparatively cheap production costs must be considered when dealing with any extensive scheme of planting. Even in unfavourable districts there are often locations where, owing to a high water table or topographical features favouring the retention of surface drainage moisture, other kinds such as Manitoba maple and varieties of the poplars and willows can be used with good success. In the so-called park area tree planting is not so much of a problem, but even here periodic dry spells are experienced and proper methods must be followed out to secure successful results.

Fig. 1—An isolated Plantation on a very exposed Site South of Swift Current. Trees up to 40 feet high, planted 4 by 4 feet enclosing Garden Plot. Photo taken in July 1934 following a series of abnormally dry seasons.

As a result of many years experience and observation the author is convinced that trees *can* be grown anywhere on the prairie where cereal crops can be raised successfully in seasons of normal rainfall. Plantations can be established when moisture conditions are favourable and from actual experience will survive several successive seasons of drought even when moisture is not sufficient to produce even a poor grain crop. The fact should not be overlooked that many comparatively old plantations have, during the last four dry years, been very seriously set back and in some cases have failed completely. But these failures are due mostly to neglect, to the planting of unsuitable varieties, to insect and rodent damage and in some cases to being buried by drift soil. These are factors, however, which can be controlled. Such failures, while naturally a source of great discouragement to the owners of the plantations, nevertheless are of considerable value in demonstrating what to avoid in the future.

Assuming therefore that it is not impractical to grow plantations in the agricultural areas of the prairies, the question arises whether belts can be established on a wide enough scale to appreciably ameliorate drought conditions, and if so would the accruing benefits compensate for the labour and expense? In trying to find an answer we are confronted by an uncertain quantity, namely, the human factor. Success really depends more on this particular factor than on anything else. Where a man has the inborn desire to grow trees and has the necessary knowledge, he will make a success of it under the most trying circumstances. But without such will to succeed no amount of legislation or government assistance is likely to bring about the desired result. If a government organization could have complete control of all factors, namely both the land and labour involved, then, with a well thought out plan, a very reasonable degree of success might be anticipated. Under our system of government this is hardly possible. What then is the most promising procedure? If it could be clearly demonstrated that field shelter-belts were a paying proposition it might not be difficult to induce farmers to undertake such plantings with confidence and with success. Unfortunately there is at present but little reliable information available on the beneficial effects of field shelters. There are, it is true, numerous instances on record where shelters have not only saved crops from drifting, but have greatly increased the yields within their influence. Every one who has lived on the prairies concedes the benefits resulting from tree-sheltered gardens and fruit plots. The field shelter idea is only going a step further and those who have had the opportunity to make extended observations are generally convinced that the idea of such plantings is basically sound.

Carlos G. Bates, Senior Silviculturist of the United States Forest Service, in a recently published statement, discussing the American shelter belt project, says, "There is an obvious reason for scepticism as to the effects which the retention of moisture through the reduction of wind movement and evaporation has upon crops. . . . The Forest Service has conducted no systematic investigations along the line of these particular problems since 1908. While innumerable examples of striking benefits to crops from shelter belts have been recorded . . ., we fully realize the extreme difficulty of finding physical situations in which 'Fair experimental conditions' are at all well satisfied. . . . What is needed for satisfying experiment and observations is an immense field laboratory with all soil conditions under control, shelter belts built to satisfactory specifications, etc." Mr. Bates further states that actually a portion of the million dollars already voted by Congress will be used in establishing such a field laboratory or demonstration area and carrying on research elsewhere when opportunity is afforded.

Exactly the same sort of thing is needed in Canada, viz.: The creating of one or more demonstration areas in each of our prairie provinces where blocks of land of a suitable size (say not less than 9 sections in a square) can be secured by the governments concerned and handled under complete control as large-scale illustration stations. In such areas all the best theories for cultural practice, local water conservation by dams, and shelter-belt plantings could be combined and maintained for a sufficiently long period of years so as to afford absolutely conclusive data.

Fig. 2—Grain field at Hugendon, Alta., June 1929. Note how the shelter belt only 3 to 4 feet high has completely stopped the drift soil and saved the crop. This field gave a good yield of grain, while the crop in that adjoining was a complete failure.

Such projects would not require immense expenditure, as in most cases the lands, already reasonably equipped with buildings, have reverted to the municipalities for taxes. After a few years of preliminary treatment, such areas should return sufficient from crops grown to carry the greater part of the cost. Would not such projects be more valuable to the west than the expenditures of huge sums in public buildings and other so-called relief projects of a non-revenue-producing nature? Such demonstration areas, if successful, would do more to encourage and stimulate the general practice of the systems advocated than anything else. If not successful, the sooner that is determined the better.

It is impossible in a short paper to take up the beneficial effects of shelter belts which have been well demonstrated already in a limited way in scattered individual examples. Suffice it to say that practical foresters with experience in prairie planting do not expect even the most extensive plantations, which it would be possible to establish artificially, either to increase precipitation or change the climate. What they do claim is that plantings would make the prairie more livable, would tend to check winds, thus conserving at least some moisture, and in some degree help to check soil drifting and would also tend to conserve winter snowfall from which some increase of moisture may be expected as against a complete run off.

It is hard to tell what the economic value would be, but there is reason to believe it would not be inconsiderable. Tree planting on the prairies, irrespective of field shelters, has already proved itself and in any event is worthy of every encouragement. In addition to the establishment of the large-scale illustration areas already referred to, all necessary assistance should be extended to individual farmers to continue planting around their building sites and to those, increasing in numbers year by year, who are actually setting out field shelters on their own initiative.

The Surface Waters of the Canadian Prairie

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ontario, February 7th and 8th, 1935.

SUMMARY.—The paper deals with a number of drainage basins in southern Alberta, southern Saskatchewan and south-western Manitoba, covering about 130,000 square miles, most of the area being treeless prairie with an average precipitation of about 15 inches.

The general relations between precipitation, absorption, evaporation and run-off are discussed, and possible methods of flood control and storage to provide local supplies are indicated.

PART I.—CLIMATE AND SURFACE WATER

The development of any area, where climatic conditions approach aridity, depends very much upon the way its water is conserved and used. It is important, therefore, that the closest possible study of our water supply should be made. This paper will deal with the relationship between surface water and climatic phenomena, and also touch briefly upon the use and physical control of our waters.

The area dealt with consists of the watersheds of the Souris and Qu'Appelle rivers; the tributary basin of the South Saskatchewan between Saskatoon and the foothills; that part of the Mississippi watershed in Canada; and a number of smaller drainage areas adjoining the above. Many of the smaller drainage basins have run-off only to lakes which have no outlet. The map, Fig. 1, shows the drainage basins referred to above, those without outside drainage being shaded. For this paper the areas outlined, being about 130,000 square miles, will be considered as the Canadian prairie. This includes practically all of the open or treeless prairie; some partially wooded hill areas such as the Cypress Hills in south-western Saskatchewan; and part of the park or grove belt to the north and east of the prairie.

The average annual precipitation[1] over this area varies from 12 to 20 inches, most of the area having between 13 and 16 inches with heavier precipitation in all ranges of hills. Fifteen inches is an approximate figure for average precipitation over the area. Mean monthly temperatures for January, the coldest month, range from 16 degrees in the south-west corner to −6 degrees in the north-east. For July, the hottest month, mean temperatures range from 62 to 68 degrees. Strong winds are common at all times, humidity is low, and evaporation is very rapid, particularly in the south-west. Most of the surface soil is very fertile, and when there is sufficient moisture, plant growth is rapid in the long days of early summer.

The waters of local origin may be divided into two classes—streams and lakes. Only these local waters are studied here, but in addition there is another important class in the streams of mountain origin flowing through the prairie. The local waters are maintained by precipitation falling upon the prairie area. The third class, consisting of the Saskatchewan river and some of its tributaries, is maintained chiefly by the precipitation falling upon the eastern slope of the Rocky Mountains. Most of the local streams contain water suitable for irrigation and industrial purposes, and with treatment could be used for domestic and municipal supply. All of the lakes are mineralized to some extent, the mineral content being higher in the lakes without outlet and increasing during years of drought. While the mountain-fed streams may eventually prove to be of more economic importance than those of local nature, the local streams are more easily utilized.

Disposal of Water Coming in Precipitation

In order to arrive at a better understanding of the relationship between surface waters and precipitation, it is suggested that the whole process of the disposal of water arriving as precipitation be considered. That process is illustrated in the diagram in Fig. 2. When water comes in the form of rain or snow, some of it is evaporated directly from the surface upon which it falls, some soaks into the

1 Where the term "annual precipitation" is used, or the word precipitation is used in a general way, it is intended to refer to all the water received as snow or rain. Ten inches of snow is assumed to ontain one inch of water.

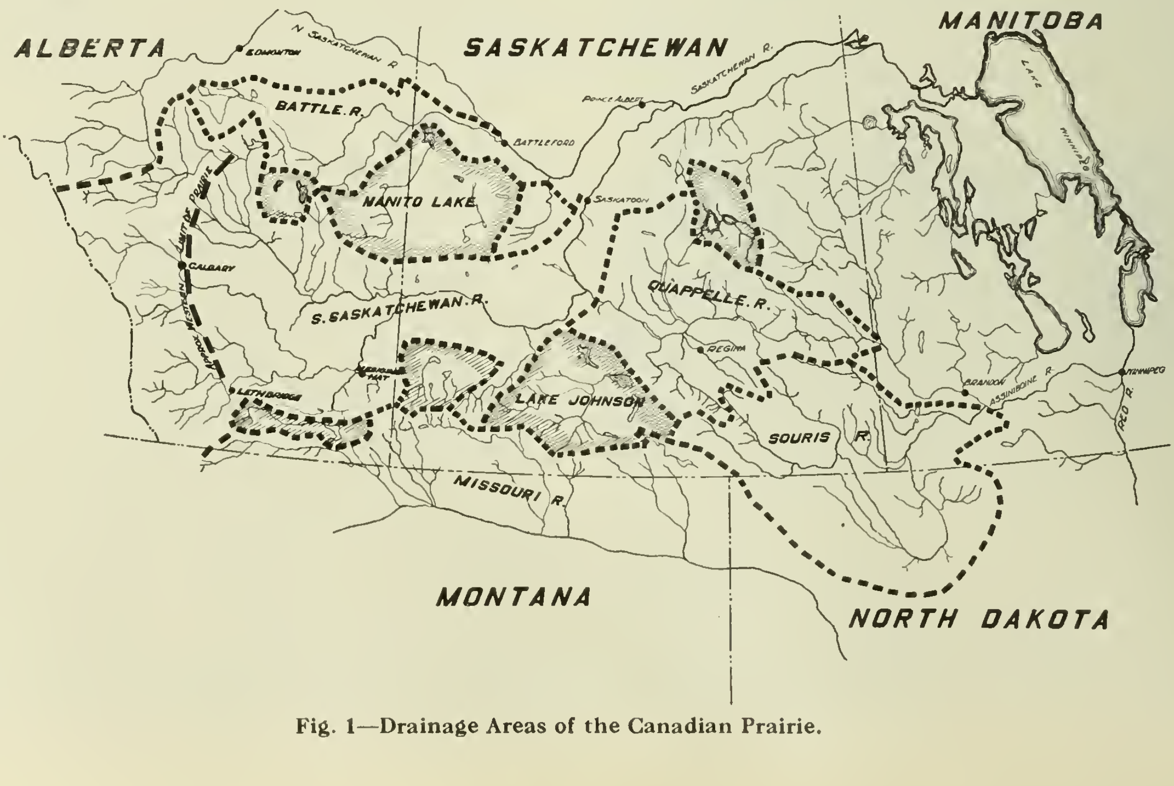

Fig. 1—Drainage Areas of the Canadian Prairie.

Table I.—Stream Flow Measurements
Annual Run-off—Inches over drainage area.

Stream	Point measured	Drainage area square miles	1919 1920	1920 1921	1921 1922	1922 1923	1923 1924	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	Average for period
Assiniboine	Millwood	7,590	1.444	2.282	4.054	2.268	.651	1.240	.67	2.17	1.50	.54	1.487
Assiniboine	Headingly	62,760	.385	.410	.816	.841	.361	.562	.20	.855	.626	.19	.525
Qu'Appelle	Tantallon	20,600	*.090	*.058	*.305	*.205	*.090	*.234	*.04	*.219	*.215	*.02	*.148
Moose Jaw Creek	McCarthy's Farm	1,960	.460	.050	.51	.651	*.219	*.612	*.05	*.943	*.23	*.002	*.373
Souris River	Wawanesa	23,400	*.177	*.055	*.177	*.266	*.072	*.258	*.03	*.438	*.260	*.041	*.177
Swan River	Swan River	1,215	3.189	4.584	7.931	7.125	1.833	5.308	2.63	6.08	2.31	.787	3.97
Saskatchewan	The Pas	149,500	1.931	2.261	2.191	2.534	1.747	2.237	1.89	3.39	3.13	1.49	2.26
Carrot River	Kinistino	320	.670	*3.110	*2.75	.597	*.417	*.486	*.51	*1.67	*.57	*.56	*1.134
North Saskatchewan	Prince Albert	46,100	3.16	2.41	2.02	2.740	2.206	2.878	2.54	3.53	3.13	1.76	2.637
Battle River	Battleford	11,850	*.80	*.48	*.16	*.133	*.135	*.341	*.35	*.96	*.38	*.12	*.386
South Saskatchewan	Saskatoon	50.900	3.15	2.07	2.08	3.060	2.179	2.688	2.21	4.89	4.46	2.31	2.91
Swift Current Creek	Swift Current	1.160	.91	.66	1.25	.891	.318	1.303	.80	1.466	1.09	.49	.918
Battle Creek	Int. Boundary	726	*.66	*.49	*1.38	*.433	*.245	*1.118	*.31	*2.51	*1.26	*.59	*.90
Frenchman River	Int. Boundary	1,875	*.81	*.48	*1.15	*.933	*.328	*1.321	*.57	*2.00	*1.07	*.35	*.901
Winnipeg River	Slave Falls	49,700	7.30	6.05	7.30	6.08	5.60	4.99	5.82	14.25	7.89	7.19	7.247

*Indicates open water record only.

surface soil and some runs off over the surface. This initial division is shown at the top of the diagram as direct evaporation, soil absorption, and initial run-off. The water absorbed by the surface soil does not remain there and should be followed further. In fertile soil, a large proportion of the water absorbed by the soil is reached by the roots of vegetation; and through transpiration is turned back to the atmosphere. As surface soil dries out, some moisture is brought up from the lower strata by capillary action and is then evaporated. These processes account for a very large percentage of the water entering the surface; but where soil is unusually porous, a portion continues to penetrate into the ground. Such water then becomes ground water. This may be added to by water from initial run-off penetrating the ground from beds of streams or ponds.

On the Canadian prairie there is an evaporation from open water equal to approximately twice the precipitation and every stream and lake loses from its surface through evaporation. Small streams also lose water through absorption along their banks, which water is turned into the air as described for soil absorption. The surface water not accounted for in the foregoing, and leaving the area in surface streams, then becomes final run-off. This run-off is generally measured as depth in inches over the drainage area.

Water which penetrates the ground beyond surface influences where it fell has been described as ground water, but such water is continually being brought to the surface again. A large percentage of it works through nearly horizontal strata and appears in valleys as springs, or it may be brought to the surface by artificial means. It is then either evaporated, or becomes part of the run-off. A part may continue to move underground until it leaves the area studied, when it becomes deep seepage.

The diagram shows typical final disposal, with the same divisions as for initial disposal, but with greatly changed proportions. The upper part of the chart is not drawn to scale for usual prairie conditions. The lower line shows the division which the author believes to exist for the Canadian prairie as a whole. It is believed that the amount lost through deep seepage is extremely small when expressed as a percentage of precipitation, and is offset by water received from mountains to the west through underground sources, and is, therefore, ignored in a study of the entire area. As will be shown later, the final run-off is about two per cent of the precipitation, some 98 per cent being returned to the atmosphere over the entire prairie area. There is a marked tendency for the percentage of water taken away by deep seepage and run-off to decrease as the drainage basin increases in size and naturally there is a corresponding increase in amount taken by evaporation. No consideration has been given in the foregoing to storage, as average conditions are being considered. Storage will take place in a year of higher than normal precipitation, or perhaps in a normal year following extremely dry conditions. When storage does take place, the proportion will be higher for the larger drainage areas.

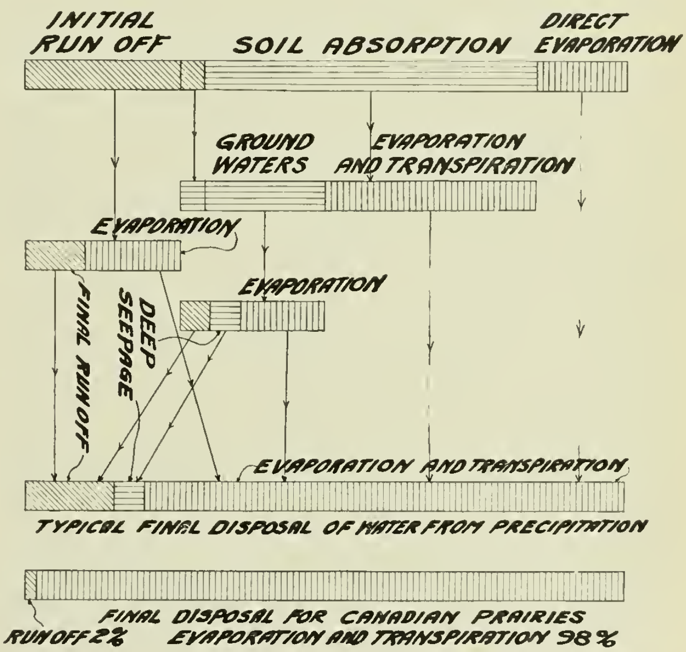

Fig. 2—Final Disposal of Water from Precipitation.

This is another factor tending to decrease the run-off (as depth over drainage area or percentage of precipitation) as the drainage area is increased. This tendency is clearly shown in run-off statistics, and while it may be significant only in semi-arid regions, its importance in these regions should be more generally recognized.

It is appreciated that even the prairie streams generally have their headwaters in ranges of hills where the precipitation is higher than the average for the whole area and topography is more rugged. This tends to increase the run-off for small streams as compared with that for large watersheds. There is, however, ample evidence to show that the average run-off is greater for small watersheds than for larger, other conditions being similar.

Run-Off and Precipitation

Table I gives the run-off for a number of prairie streams and a few in adjoining wooded areas for the ten water-years from October 1st, 1919, to September 30th, 1929, taken from the Water Supply Papers of the Dominion Water Power and Hydrometric Bureau. While the measurements for Qu'Appelle and Souris rivers cover the open water period only, it is believed that the winter flow would be very small when expressed as depth over drainage area, and that the total run-off is little over two-

Fig. 3—The Souris River Near Estevan, Sask.

tenths of an inch. The Souris river, measured at Minot for twenty-two years by the United States Geological Survey, gives an average of twenty-three hundredths of an inch. Smaller streams of the Mississippi and South Saskatchewan river watersheds show higher run-off, but on the other hand, there are large areas where there is no outside run-off. Taking all drainage basins into consideration, the author has suggested three-tenths of an inch as a figure covering the total run-off from the area, and is satisfied that it does not exceed this amount. This would be two percent of precipitation if an estimate of fifteen inches is accepted for the average value.

While the stream-flow data available are valuable in any study of waters, in most instances the figures cover a very short period, and there are streams for which there are practically no data. Meteorological records are not as comprehensive as one would like, but they cover the prairie area better and for a longer period than the hydrometric records do. It is important then that an endeavour should be made to establish the relationship between meteorological records and stream flow.

The author has endeavoured to study available literature as well as the prairie records in a search for this relationship. A number of simple formulae and graphs are available which attempt to give the approximate relationship between annual precipitation and run-off. Most of these are clearly inaccurate with a light precipitation. Some seem to give approximately correct results for small drainage areas, say under 500 square miles, but none are of value for the larger basins. Unquestionably the proper approach is to think of the run-off as a residue of precipitation after deducting the losses for evaporation, transpiration and seepage. Professor E. F. Chandler[2] of Grand Forks, N.D., suggests 20 inches as the approximate requirements for evaporation and transpiration in northern states and thinks that, generally speaking, when precipitation exceeds 20 inches, the amount over 20 inches will be found in run-off.

2 "What Becomes of Rainfall in North Dakota," University of North Dakota Quarterly Journal, January 1925.

This rule may not be of direct help as our precipitation is under 20 inches, but it does bring out an important fact concerning run-off, namely, that *the average precipitation does not meet the normal demands of transpiration and evaporation.* The streams originating in the prairie and lake levels, then, are dependent upon water from snow which melts and runs off when the ground is frozen; a small run-off from unusually heavy rains falling on small areas faster than it can be absorbed; and a very small discharge from ground water accumulated in unusually porous soil deposits.

The most complete general study of the subject which the author has found is contained in a paper[3] by Mr. Meyer who also deals with the matter and gives his charts in his book.[4] His method is to compute all losses from precipitation, taking into consideration the physical features of the watershed as well as all meteorological data.

Mr. E. G. Marriott, A.M.E.I.C., of Victoria, B.C., states[5] that he found Mr. Meyer's method worked out well with streams near Kamloops, B.C., where annual precipitation is as low as ours. The author has not been as successful in applying the method to prairie streams, though it may be that the data used were not complete enough. Certainly Mr. Meyer's approach to the subject is scientific and logical, but it is doubtful if results would be accurate enough to warrant the work involved. Methods which might be entirely practicable in areas where precipitation is greater, and where twenty to fifty per cent of precipitation finds its way into streams, may not be feasible

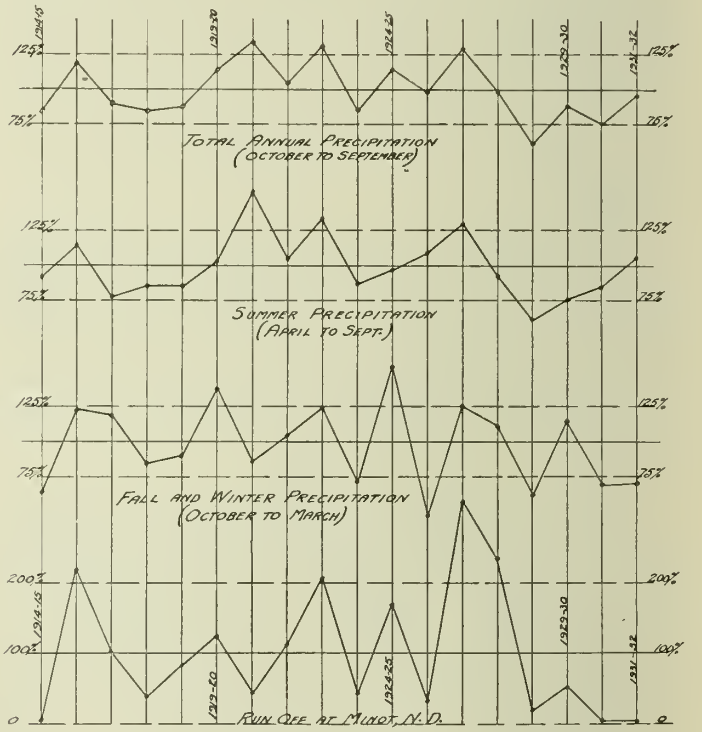

Fig. 4—Precipitation and Run-Off, Souris River above Minot, N.D.

in an area where run-off is only two to five per cent. Changes in meteorological conditions which would be hard to record might easily make a difference of one or two per cent in the amount of the annual precipitation reaching streams. Such variations would approach fifty per cent of our run-off, but would be barely noticeable in some humid districts.

3 "Computing Run-Off from Rainfall and other Physical Data," by A. F. Meyer, Vol. 79, Transactions of the American Society of Civil Engineers, 1915.
4 Elements of Hydrology, A. F. Meyer, Wiley, New York.
5 The Engineering Journal, September 1927.

All who have studied prairie conditions will agree that the dependable surface flow from small areas is from winter precipitation. The author believes that the flow of the larger local streams is dependent chiefly upon snowfall and fall rains. The fall rains probably affect the run-off in two ways. Professor Chandler suggests that when the surface soil freezes in a wet condition, it is more effectively sealed, and a larger portion of water from melting snow runs off in the spring. It is believed too that more of the fall rain penetrates the ground than any other precipitation. From this ground storage some water finds its way into streams for flow in the winter (where any exists) or during the following summer.

No formula is suggested here for determination of run-off from precipitation but it is believed that our stream flow is primarily dependent upon fall and winter (October to March inclusive) precipitation. Where the water year (October 1st to September 30th) is used, it is suggested that the flow of the prairie streams is dependent upon the precipitation of the first six months. As the winter flow is extremely small, the calendar year may be used instead, and stream flow considered as dependent upon the precipitation of six months beginning the preceding October 1st.

Heavy rains in September seem to affect the run-off for the following year also, probably through increased yield from the ground waters. September rains are usually light, however, and for convenience, the six months beginning October 1st has been adopted as the period during which precipitation has the controlling effect upon stream flow.

Figure 4 is a diagram showing the approximate relationship between fall and winter precipitation, summer precipitation, total precipitation and run-off for the Souris river at Minot, N.D. Run-off is shown as measured by the United States Geological Survey and is expressed as a percentage of the average for the period. Precipitation is estimated from the records published by the province of Saskatchewan and state of North Dakota, and is expressed in the same way. While run-off does not follow fall and winter precipitation closely, there is a much closer relationship than that existing between total precipitation and run-off. During some years, the summer and winter precipitation shows the same trend, in which case it is difficult to see which affects the stream flow. Where they show opposite trends, the winter precipitation unquestionably is the important factor. For instance, during 1925 and 1926 the fall and winter precipitation is 72 per cent of the average, the summer precipitation is 109 per cent and the total 98 per cent; yet the stream flow is only 34 per cent. For 1927 and 1928, the fall and winter precipitation is 112 per cent, the summer 93 per cent and the total 99 per cent while the run-off is 185 per cent of the average.

The curves in Fig. 5 are submitted as an approximate guide in estimating run-off from fall and winter precipitation. It is believed that size of watershed is the factor next in importance to precipitation in estimating run-off; that feature, and also to some extent topography of basin has been allowed for by giving separate curves for different sizes of drainage area. This chart has been prepared by plotting a large number of run-off figures from the Dominion Water Power and Hydrometric Bureau reports, and those secured by the Canadian National Railways engineers. Needless to say, stream flow records will be found which differ widely from the chart, but it is believed that the chart will be of value where few data are available on which to base an estimate. Small drainage basins, particularly those in rolling prairie or hilly areas, will in some years have additional run-off from sudden summer showers. Such run-off is not dependable, however, and probably has little, if any, effect on streams of over one thousand square miles drainage area.

Other Factors Affecting Run-Off

Some of the other factors affecting stream flow should be considered. Probably the nature of the spring thaw is as important as anything else, for when the thaw is continuous and abrupt, a larger proportion of water from snow joins the run-off. Where the thaw is gradual and broken by spells of cold weather, the water is largely evaporated or absorbed by the soil. Unusually high temperatures continued through the season will naturally reduce the run-off, as evaporation will be greater.

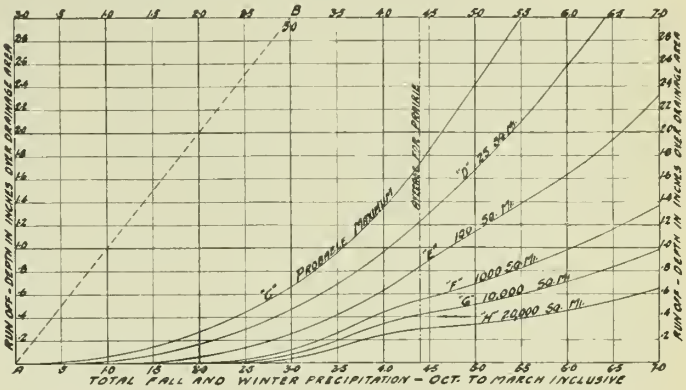

Fig. 5—Run-Off from Canadian Prairie, Regina, Sask.

Note:—C, D and E will apply to rolling prairie or hills, clay soils and quick melting of snow. F, G and H will apply to watersheds consisting of part level and part rolling prairie, average soil and temperatures.

The rolling or hilly watershed will give a greater average flow and more dependable run-off than the more level prairie. Under some conditions, however, the prairie with very gentle slopes will produce run-off from melting snow nearly equal to that from hilly areas. Lakes and sloughs tend to greatly reduce the run-off from any prairie area. The nature of soil may have little effect for drainage basins in excess of one thousand square miles. If sandy soils are present, more water will be absorbed, but this may be offset by the increase in stream flow from springs.

When the influence of forests on stream flow is touched upon, a field is entered where a very wide divergence of opinion exists. Persons interested in effect upon climate will tell of the vast amount of water returned to the atmosphere through transpiration from trees, and express the belief that this tends to decrease the run-off. On the other hand, there are those interested in water supply who tell of the way tree growth stops evaporation from ground and water surfaces, and suggest that stream flow is increased by this effect. Most of the opinions of meteorologists give little weight to the effect of trees on climate or stream flow. For example, Professor Willis Moore of the United States Weather Bureau[6] observes that deforestation, drainage and cultivation has not materially altered climatic conditions and referring particularly to floods states that effect of deforestation is limited to small area of mountain districts. However a different attitude is represented by Geddes,[7] who states that evaporation takes place more rapidly from a surface covered with vegetation than from a free water surface, other things being equal.

Engineers differ also but it appears that those who have given most careful study to the subject do not credit forests with having as great an effect as is commonly supposed. Mr. Meyer[8] points out the wide difference in claims for effect of vegetation and gives the following as his estimate of water used in transpiration—9 to 10 inches for grains and other agricultural crops; 8 to 12 inches for

6 "Descriptive Meteorology."
7 Meteorology, A. E. M. Geddes, Van Nostrand, New York.
8 Elements of Hydrology, A. F. Meyer.

deciduous trees; 6 to 8 inches for small trees and brush; 4 to 6 inches for coniferous trees.

Those who have observed the behaviour of single trees or shelter belts planted in the drier areas of the prairie are ready to believe that they will return large quantities of moisture to the atmosphere when it is available. The tendency for roots of trees to run a long distance and draw moisture from large areas is quite remarkable, but when we study the stream records of the prairie and adjoining areas, it would appear that tree growth increases the run-off. The author wishes to support the doctrine that forests are primarily the result of certain climatic conditions rather than the cause. It should be admitted then that there are some natural climatic differences between the naturally forested area and the open prairie. This makes it difficult to compare the behaviour of streams in the open prairie with those in the forest or park belt, but nevertheless, the comparison is interesting.

Swift Current creek measured at Swift Current is one of the prairie streams having considerably heavier run-off than many of its neighbours, but comparison with the Swan river in the forest area to the north is quite surprising. For the ten-year period covered by Table I the average run-off for the former is 0.918 inches while the latter has 3.97 inches. Drainage areas are about equal, while information available concerning soil and topography lead to the belief that these factors would be similar in their effect. Meteorological records indicate that the Swan river watershed received about one and one half inches greater annual precipitation for the period considered. There is a marked difference in mean temperature, particularly for the winter months. The mean monthly temperature for January at Swift Current is 7 degrees, while at Swan river it is − 6 degrees. The higher average temperature at Swift Current is largely brought about by pronounced warm waves coming with the Chinook winds, when the snow is often melted and water evaporated, leaving little for absorption or stream flow.

It should be remembered that the run-off in the prairie and adjoining streams comes entirely or very largely from the fall and winter precipitation. At that time, trees are dormant and will not be drawing upon the supply of water. Probably the shading of trees and the reduction of wind reduces evaporation, and it is the author's belief that the presence of trees in or near the prairie area tends to increase the run-off. If it is possible to materially increase the tree growth on the prairies, it should bring about a slightly increased average flow of streams or, at least, offset any reduction brought about by cultivation of part of the surface drained.

Are Permanent Changes Taking Place?

This brings us to the important question of permanent or progressive change. There is a common belief in the theory that our streams are now much smaller and the lakes lower than they were one or two hundred years ago. While there may have been some change, it certainly is not as great as is popularly supposed. The only authentic record of any permanent or progressive change in streams or lakes in or near the Canadian prairie, which the author has found, is that for Devils Lake in North Dakota. Professor Chandler[9] states that the lake level has fallen twenty-two feet in the past fifty years, while no appreciable decline in precipitation has occurred. He suggests in explanation that the cultivation of the surrounding prairie has slightly decreased the run-off. Professor Howard E. Simpson, State Water Geologist of North Dakota, believes too that the cultivation of the prairie has slightly reduced run-off.[10]

Probably some of the streams and lakes are being affected in a similar way, though statistical evidence has not been found. The year 1915 saw an extremely low flow in local streams, the flow for the Qu'Appelle and Souris rivers being the lowest recorded until the severe drought of 1929 occurred. There are some gauge records on Lake Johnson and Quill Lakes but unfortunately the record is very short, and has not been maintained during recent years. At Lake Johnson, the level held about uniform from 1918 to 1924, then rose 3 feet from 1924 to 1928. A drop of 2 feet occurred during the years 1929 to 1930, leaving the level one foot higher in 1930 than in 1918 when the record was started. The level has continued to drop during the severe drought, probably at the rate of one foot per year, and it is believed that the water is now 3 feet lower than in 1918. The record, however, is too short to show whether it is a progressive lowering, or whether it is a matter of fluctuations.

Some interesting notes on the Qu'Appelle river are contained in the report of Professor H. Y. Hinds[11] who explored this area in 1857. He referred to the Qu'Appelle Lakes as "full of weeds and having a disagreeable odour," and described the river above Craven as a stream "nineteen feet wide and one and one half feet deep." Altogether his notes lead the author to believe that the lakes and streams were much the same in 1857 as we find them today.

Variations

Needless to say, wide departures from the normal or average flow of streams must be anticipated. During the recent drought the Qu'Appelle and Souris rivers have had for five consecutive years discharges less than 25 percent of the long time mean. The variations in smaller watersheds are greater, and where there is only gently rolling prairie, no run-off has occurred in several of the past five

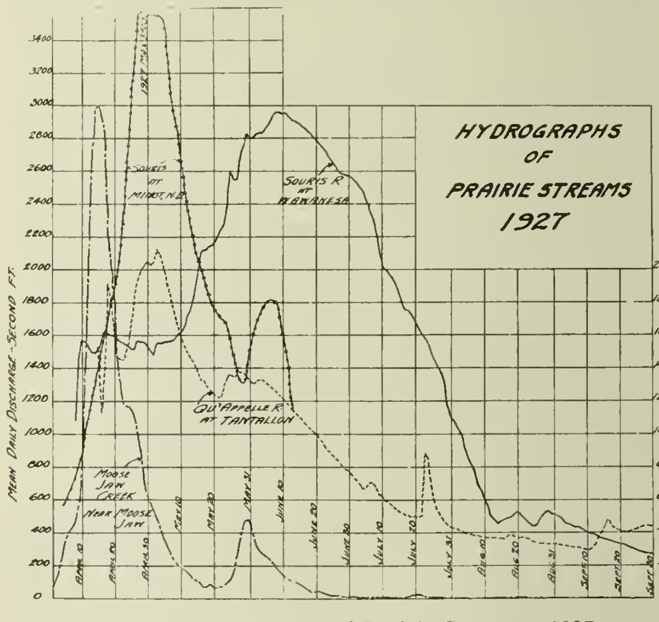

Fig. 6—Hydrographs of Prairie Streams, 1927.

years. With rugged topography, some run-off occurs almost every year. The author has had under observation reservoirs on coulees near Avonlea, Tilney, Darmody and Central Butte during the recent drought, and found that some run-off was secured each year, and reservoirs have been satisfactory for railway service.

Precipitation for the Canadian prairie shows some tendency to follow the sun spot cycle of eleven and one quarter years, recent dry periods of from two to four years having centred upon the years 1909, 1920 and 1931. The flow of streams, however, is likely to be more irregular than the

9 Bulletin No. 11, January 1930, of the University of North Dakota.

10 "Geology and Ground Water Resources of North Dakota."

11 Report on the Assiniboine and Saskatchewan Exploring Expedition, 1859.

annual precipitation, and it is doubtful if the theory of regular recurring cycles can be relied upon.

Flood Stages

The maximum and minimum flow of streams are as important as total discharges. The maximum flow is of particular interest, for it becomes the flood stage in years of heavy flow. Figure 6 shows hydrographs of the Souris, Qu'Appelle and Moose Jaw rivers for part of the open water period of 1927, giving the mean daily discharge in cubic feet per second. It will be found that in years when the average or more than average flow occurs, hydrographs follow somewhat similar curves. This then may be taken as typical of the high water flow for many of our streams. The Souris river at Wawanesa usually has its high stage much earlier than in 1927. The maximum recorded was about double the highest for 1927, and occurred April 19th, 1916. This early and high stage of the Souris in 1916 was probably an important factor in bringing the record flood for the lower Assiniboine that year. It is interesting to note that the Moose Jaw creek with a drainage area of 1,960 square miles had a higher flood stage than the Qu'Appelle with 20,600 square miles; and the Souris had a higher stage at Minot with 10,270 square miles than at Wawanesa with 23,400 square miles.

To facilitate comparison between the flood flow of our streams and those of other parts of the continent, Table II has been compiled showing the flood stage of typical streams. It is recognized that flood stages, when expressed as cubic feet per second per square mile, will be greater for small watersheds than for larger, other things being equal. The streams listed have, therefore, been divided into five groups on the basis of drainage area. In each group the first one or two streams are on the Canadian prairie, and the remarkable difference between our floods and those in more humid districts is evident. No attempt is made to describe the climatic features affecting each stream, and little is submitted concerning the physical characteristics of the drainage area. Nevertheless, certain conclusions are quite obvious. For the first three groups, it is evident that the flood stage is the result of the combined climatic conditions and physical features of the watershed. For the larger watersheds in groups four and five, it is believed that the nature of the watershed has little effect as compared with the climatic conditions. For instance, the watershed of the Qu'Appelle river above Lumsden is made up largely of rolling prairie and hills with clay and loam soils. Judged on the basis of topography, lake storage, soil and vegetation, one would expect it to produce greater floods than the Assiniboine above Millwood, Manitoba, or the Gatineau in Quebec. On the contrary, the flood stage for the Qu'Appelle is only 0.408 cubic feet per second per square mile, while the other streams have 2.345 and

Table II.—Flood Stages of Typical Streams

Group No.	Stream	Location	Drainage area sq. m.	Maximum Recorded Stage Second-Feet	Maximum Recorded Stage Second-Feet per sq. mile	Date	Ref.	Remarks
1	McEachern Creek	Near International Boundary, Sask.	160	1,050	6.281	Apr. 3, 1927	A	Rolling prairie
	Long Creek	Radville, Sask.	190	Approx. 2,000	Approx. 10.526	May 24, 1933		Rolling prairie. Believed heaviest flow since settlement of this area—observed by the Author.
	Baker River	Near Anderson Creek, Wash.	184	—	200	Dec. 1917	B	Probably mountain stream.
	Seekonk River	Providence, R.I.	190	—	57	1867	B	
	Catskill Creek	South Cairo, N.Y.	210	—	100	Spring 1901	B	
	Belly River	Mountain View, Alta.	121	16,000	Approx. 132	Approx. June 1908	A	Mountain stream.
2	Battle Creek, Southern Sask.	International Boundary	726	3,200	4.408	March 1927	A	Rolling prairie and hills.
	Bow River	Banff, Alberta	852	14,100	16.55	June 1923	A	Mountain stream.
	Mad River	Osborne, Ohio	649	—	117	March 1913	B	
	Little Tennessee River	Jackson, N.C.	675	—	85.3	Dec. 1901	B	
	Raritan River	Bound Brook, N.J.	806	—	64.5	Sept. 1882	B	
3	Wascana Creek	Regina, Sask.	1,220	3,080	2.525	Mar. 31, 1925	A	Part rolling prairie—part nearly level prairie.
	Swift Current Creek	Swift Current, Sask	1,160	6,300	5.431	April 1917	A	Rolling prairie and hills.
	Swan River	Swan River, Man.	1,215	8,460	6.963	April 1925	A	Wooded and park land.
	Thames River	Byron, Ont.	1,230	23,190	18.85	March 23, 1926	C	Hilly—Wooded and agricultural land.
	Yuba River	Near Smartsville, Calif.	1,200	—	92.5	Jan. 1909	B	
	Hehigh River	Bethlehem, Pa.	1,240	—	69.8	1902	B	
	Scioto River	Columbus, Ohio.	1,047	—	80.8	March 1913	B	
	Miami River	Dayton, Ohio	2,450	—	100	March 1913	B	
4	Qu'Appelle River	Lumsden, Sask.	6,540	2,670	.408	1927	A	Rolling prairie.
	Souris River	Estevan, Sask.	4,550	2,850	.626	1916	A	Level and rolling prairie.
	Assiniboine River	Millwood, Man.	7,590	17,800	2.345	Apr. 1922	A	Wooded and park country largely agricultural.
	Gatineau River	Near Mercier Dam, Quebec	6,250	42,300	6.768	May 24, 1926	C	Wooded with good lake storage.
	Susquehanna River	Williamsport, Pa.	5,670	—	61.7	1889	B	
	Deleware River	Lambertsville, N.J.	6,855	—	37.1	Jan. 1841	B	
	Little River	Cameron, Tex.	7,010	—	92.3	Sept. 1921	B	
5	Qu'Appelle River	Tantallon, Sask.	20,600	2,530	.122	Apr. 1925	A	Largely open prairie. Some lake storage.
	Souris River	Wawanesa, Man.	23,400	6,100	.260	Apr. 1916	A	Typical prairie watershed very little lake storage.
	Winnipeg River	Minaki, Ont.	27,200	55,400	2.04	June 1927	A	Wooded—large lake surface.
	Ohio River	Pittsburgh, Pa.	19,100	—	22.98	1907	B	
	Tennessee River	Chattanooga, Tenn.	21,382	—	34.37	March 1867	B	
	Susquehanna River	Harrisburg, Pa.	24,030	—	30.60	June 1889	B	

"A"—From Water Resources Paper No. 66, Dominion Water Power and Hydrometric Bureau.
"B"—From table of "Maximum Observed Floods," "Elements of Hydrology" by A. F. Meyer.
"C"—From Water Resources Paper No. 58, Dominion Water Power and Hydrometric Bureau.

6.768 respectively. In the central and southern states, streams of approximately the same drainage area produce floods of 37.1, 61.7 and 92.3 cubic feet per second per square mile.

It is evident, then, that our streams have extremely light flood stages due to climatic conditions. However, as the record is a short one, is there not a possibility of some year in the future producing floods very much in excess of those now recorded? It is the author's opinion that this

Fig. 7—A town in the Dry Belt, Hodgeville, Sask., 1927.

is not only a possibility but a probability. A very little difference in meteorological conditions as compared with previous years, when records were established, may bring floods considerably higher than those of the past.

It is interesting to note that Meyer's flood formula[12] intended for Minnesota conditions seems to agree roughly with records of the prairie streams of drainage areas under five hundred square miles, and the streams in wooded areas to the east and north. For the large prairie watersheds, Mr. Meyer's formula would give results two to five times greater than the maximum recorded. This, of course, shows that the formula does not apply to the large prairie drainage areas, but it may also be taken as another indication that we should expect greater floods.

Mr. Meyer suggests that for the northern states the maximum floods for streams with drainage areas under one thousand square miles will occur from excessive rain, while for areas larger than one thousand square miles, melting snow (sometimes accompanied by rain) will cause the extreme stage. The author would suggest 500 square miles as the dividing line for prairie streams. For the smaller watersheds, soil and topography are important as well as the nature of the storm. For drainage basins over 500 square miles, the factors affecting flood are similar to those affecting total discharge; namely, condition of the watershed at the time of freezing during the preceding fall; the amount of snow; and nature of the spring thaw—the quick continuous thaw, of course, being most productive of flood waters.

A study of Table II shows conclusively that forests cannot have the effect generally credited to them in preventing flood. Rather, it would appear that they tend to increase the stage for large watersheds. Mr. Meyer has arrived at similar conclusions, for he says: "The available information on the subject does not indicate that forests have any material effect upon the extreme flood flow. They have a tendency to reduce the ordinary flood flow somewhat. In northern Minnesota forests have aggravated spring floods by retarding the melting of snow until warm April rains set in."

PART II.—USE AND PHYSICAL CONTROL

Flood Control

This is a subject which has not been given much attention on the prairie during recent years, but as suggested above, may come to the fore in the future. Some water courses have become partially blocked during dry years from soil drifting, deposit of silt, and growth of brush, which will tend to increase trouble when high water comes again.

Three general methods are adopted in flood control work—storage reservoirs, dykes and flood channels. The first is of greater interest to residents on the prairie, because it is frequently suggested that reservoirs can be combined for flood control and other utility. While it is evident that it is impossible to secure maximum flood benefit from a reservoir and at the same time secure satisfactory service for other purposes, it is true that every reservoir used for impounding spring run-off will tend to reduce floods on large watersheds.

Drainage

Drainage is also a subject that has not been considered a great deal on the prairies during the past few years. It is believed, however, that some drainage work may be justified and where it is undertaken, the closest possible study of climate should be made.

One phase of the subject is the matter of culvert and bridge openings to be provided in highway and railway grades and spillways for dams. This is one place where the average engineer has not been guided by experience in more humid areas. Generally, waterway openings have been based on appearances, and observation of stream or water-course for a short period. Where observations were made during the dry part of a cycle, the openings were often made very small for the drainage area.

Probably the most widely quoted rule for determining culvert openings is the Talbot Formula.[13] This, with lowest factor (for flat land), gives openings as follows:—

1.25 square miles drainage, 30 square feet of opening.
12.5 square miles drainage, 169 square feet of opening.
25 square miles drainage, 285 square feet of opening.
125 square miles drainage, 951 square feet of opening.

It is true that that formula was intended for the Mississippi valley where rainfall is heavier. On the other hand, there is sometimes heavy rainfall over small areas, and our soil as a rule does not absorb rainfall quickly. The extreme run-off may occur so infrequently that one may not be economically justified in providing sufficient waterway to handle it in every case. However, where insufficient waterway opening is likely to result in serious damage, it is believed that waterways at least twice as large as those commonly used on the prairie should be provided.

Fig. 8—C.N.R. Track West of Hodgeville, Sask., 1927.

Storage

Mention has been made of the extremely low run-off from the prairies when expressed as a percentage of pre-

12 A. F. Meyer, "Elements of Hydrology," 2nd ed., p. 369.

13 American Civil Engineers Handbook, 5th edition, p. 2009.

cipitation. It should be remembered, however, that drainage areas are great, and there are large quantities of water available for local use. Storage may be made in various types of reservoirs, from the small dugout in a farm yard to comparatively large artificial lakes; or through control of levels in existing lakes such as Last Mountain Lake (Long Lake). The uses may be just as varied, including domestic, municipal, industrial, irrigation and recreational purposes. The author believes that one of the best fields for the use of surface water is in reservoirs of from 10 to 1,000 acre feet capacity, made by constructing dams in coulees, which are ordinarily dry but have a spring flow from melting snow. The smaller reservoir of this type would be for individual farm use, supplying water for the home (filtering and other treatment would make such water suitable for domestic use if well water is not available), for stock and irrigation. The larger sizes would be suitable for municipal or government reservoirs and might be used in some cases for industrial purposes, and in most cases for recreational purposes. A lake or reservoir of this kind, especially when improved by planting trees around its shores, would make an attractive recreational centre, providing swimming, boating and auto camps. Where sufficient flow exists, it would be advisable to have two or more reservoirs on the same coulee, the level of the lower maintained by letting the water down from the upper storage. The lower would, of course, be the one improved. The quality of the water in such reservoirs depends very much upon the amount of deep water. Wide expanses of marsh and shallow water make excellent breeding places for water fowl, but tend to lower the quality of the water for industrial and recreational purposes. Where the quality of the water is important, it is suggested that as much deep water (over eight feet) be obtained as possible. This could be done by excavating channels through parts of the reservoir which would naturally have only shallow storage. The earth removed would form islands or steep banks around the outside of the reservoir. It is the conviction of many who have studied the matter carefully that such artificial lakes, properly maintained for recreational purposes would be of great value to the prairie. Everything which tends to make the country a more attractive place in which to live is of practical value.

Another type of reservoir which might be used in places is an imitation of the "oxbow" lake or slough, sometimes found in river valleys. Where a creek or river meanders through a wide valley, a channel could be excavated between two adjoining bends, and earth used for dams at both ends of the channel cut off. A pipe with check valve, or gate valve manually controlled, would permit the severed channel to fill to the height of the flood water but would hold such water after the flood recedes. This type of reservoir would eliminate the necessity for an expensive spillway, and avoid obstruction to the stream.

In connection with all reservoirs, it is felt that more could be done in using water for irrigation of small areas. It is realized that irrigation in general is not a paying proposition, especially with existing prices for agricultural products; but a small area irrigated for garden and feed, especially if that area is adjoining the farm home, would remove much of the hardship experienced during years of drought.[14]

The larger projects for reservoirs should not be carried out without proper engineering advice, but engineers who have an opportunity to advise on matters of this kind will have to be careful to avoid unnecessary expense on any undertaking.

Many agricultural leaders and engineers are advocating more extensive use of the small reservoir to insure a farm

Fig. 9—A Beach on one of the Qu'Appelle Lakes near Lebret, Sask.

supply. The Hon. Mr. Weir in a letter which appeared in Regina papers stated: "A thick shelter belt around a small trench or reservoir for water supply should make it possible for any farm to handle stock (sufficient to be self-sustaining) in this way." Mr. T. C. Main, A.M.E.I.C., has strongly urged, among other things, the use of small reservoirs for farms in the dryer areas.[15]

A type of irrigation practised extensively in Montana, and in the south-west Canadian prairie area, is known as "flood irrigation."[16] This primarily consists of diverting or temporarily impounding the spring flood water to give the land a spring irrigation. Mr. H. L. Lantz, County Extension Agent, Malta, Montana, in a letter of February 11th, 1932, advises that this work has been very successful in that area. He states "To date, I have personally surveyed out one hundred and sixty-seven systems covering over 14,000 acres." Professor M. L. Wilson, Head of the Department of Agricultural Economics, University of Montana, in a letter of January 30th, 1932, states that flood irrigation was included in their programme for betterment of dry areas started ten years earlier, and was found to be constructive.

No attempt is made in this paper to deal with the administration of our waters except to mention that it is illegal to impound or divert any surface water without government permission. Problems of administration will become greater as more water is utilized. It is important that the taking of hydrometric records should be continued and extended, and that the material secured since 1929 should be published at an early date.

The author hopes that the foregoing notes will aid by showing the need for careful study, and thus help towards the better utilization of our surface waters.

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14 Literature is available to those interested in the subject. Bulletin No. 5 of the Reclamation Service of Canada on "Farm Water Supply" was obtained from the Dominion Water Power and Hydrometric Bureau recently, and probably is still available. The United States Department of Agriculture Farm Bulletin No. 828 on "Farm Reservoirs" contains similar information. The reports of the Dominion Field Husbandman, Agricultural Department, Ottawa, for 1928 and 1930 describe small reservoirs constructed for watering stock at the Range Experimental Station, Manyberries, Alberta. The Department of Agriculture Bulletin No. 125—"Use of Irrigation Water on Farm Crops" and bulletin No. 7 of the Dominion Water Power and Hydrometric Bureau give valuable data on this phase of the subject.

15 Report to the Commission on Conservation and Afforestation, Province of Saskatchewan 1932. See also paper on Drought and Soil Drifting in Western Canada, Engineering Journal, June 1932.

16 See Circular No. 17—Montana State College.

Water Conservation in the Prairie Provinces

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Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

SUMMARY.—The paper deals with conservation of water, which, together with improved methods of cultivation, and the planting of trees and hedges is a possible means for rehabilitation of the drought area. The author touches on the waste which has occurred in the past and considers that increased evaporation over a long period is the chief cause of the drought. He objects to general irrigation for cereal crops and refers to the economics of the situation. A number of specific conservation projects are described, and it is urged that action be taken without delay by appointing a small commission of technical men to make a definite study and co-ordinate the work of government departments, universities and private individuals.

A paper by the author entitled "Drought and Soil Drifting in Western Canada" appeared in The Engineering Journal of June 1932. In that paper the distressing condition of the so-called drought area was described. The situation now is much worse than it was then and the affected area is larger. The problem is now of more than local or provincial interest and is being looked upon from the national point of view. This attitude is logical, as it is difficult to visualize a high degree of prosperity for Canada as a whole while the great agricultural area of western Canada is in its present serious condition.

It is the author's opinion, after many years of serious study of this problem, that man must assist nature if this area is to be rehabilitated and the disastrous effects of future drought periods minimized. Three principal ways in which man can assist appear to be (1) improved methods of cultivation, (2) planting trees and hedges, and (3) conservation of water.

In the present paper it is proposed to deal chiefly with the reasons for, and the possibilities and limitations of water conservation. It is hoped to present to the country, through the engineering profession, a practical basis for the conservation and utilization of moisture in this semi-arid, but otherwise fertile country.

Deciding where the boundary of the drought area lies is a difficult task, as there are no definite lines of demarcation. Moreover, there are oases of practically unaffected country in drought territory, and miniature deserts in normal districts. The area shown shaded on the map in Fig. 1 is the author's idea of that part of the prairie provinces which may be considered as the present drought region.

It must be pointed out, however, that drought is a potential enemy to the entire country from the Rocky Mountains to Ontario and from the international boundary to as far north as agriculture may go. Records show that precipitation in general decreases from south to north in our western country. Furthermore the land north of the North Saskatchewan river is for the most part lighter than in the south; hence, with lighter land and less precipitation, the north country is in greater danger than the south of becoming desert, once the tree growth is eliminated.

Waste of Surface Water

It is an axiom of climatology that the ratio of water to land has an important effect on climate. The natural corollary is that an acre of water or marsh, in a semi-arid region, must be more valuable than an acre of high class wheat land. Nature unfortunately was niggardly in providing water areas in the drought region and indeed in the southern, central and westerly portions of the three prairie provinces considered as a unit.

In spite of nature's parsimony, man has lost few opportunities of draining lakes, sloughs and marshes in order to increase his land holdings in a country where the ratio of water to land was already too small. There has been a general idea that the bed of a lake or marsh must necessarily be exceedingly fertile. As a rule the contrary is true, as it usually takes many years for a former lake bed to sweeten up sufficiently to grow high class crops. This is particularly true in western Canada where most of the lakes are inclined to be saline.

Normal drainage due to the construction of highways and railways has also contributed to loss of ground and surface water. This loss was more or less unavoidable; although the author believes that road drainage has been overdone; in fact, was frequently part of reclamation schemes.

Loss Through Evaporation

The climate of a region is usually classified according to its mean annual precipitation. Frequently the evaporation factor is somewhat neglected. As a matter of fact

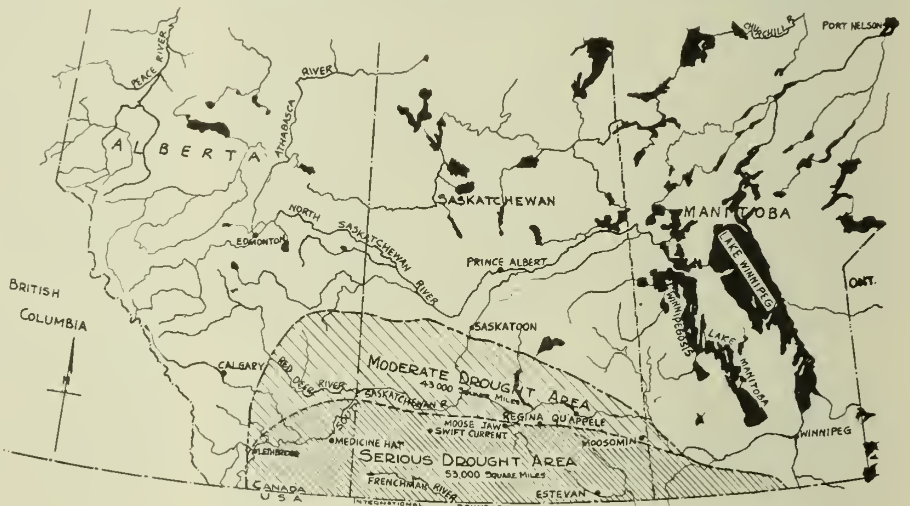

Fig. 1—Drought Area in Western Canada.

evaporation, next to precipitation and temperature, is the most important factor in climate. It cannot, of course, be divorced from temperature, though not entirely dependent on it.

The layman, in thinking of the recent drought in western Canada, lays the blame entirely on lack of precipitation. It is true that precipitation was low for several years, and undoubtedly this was a factor. On referring to the graphs in Fig. 2, however, it will be seen that while in general precipitation was low from 1928 to 1931, the past two years have been normal or above normal in this respect over a considerable portion of the drought area. It is interesting and encouraging to note that the twenty-year moving averages shown in the figure do not indicate any tendency toward lower precipitation in the prairie country. Winnipeg seems to be an exception; but apart from a comparatively small area in the south and west, Manitoba has not suffered from lack of precipitation.

Increase in evaporation, caused in turn by an increase in temperature, is perhaps quite as important a factor in our drought situation as the more obvious decrease in precipitation.

The twenty-year moving summations of yearly mean temperatures plotted in Fig. 3 indicate what has been happening in western Canada in the period during which temperature records have been kept. It will be noted that the mean daily temperature in Winnipeg for the twenty-year period ending 1931 was 3.9 degrees F. greater than for a similar period ending 1892. All through the prairie provinces, except at Edmonton, this temperature increase approximated that of Winnipeg. In the Edmonton district it increased, but not to the same extent.

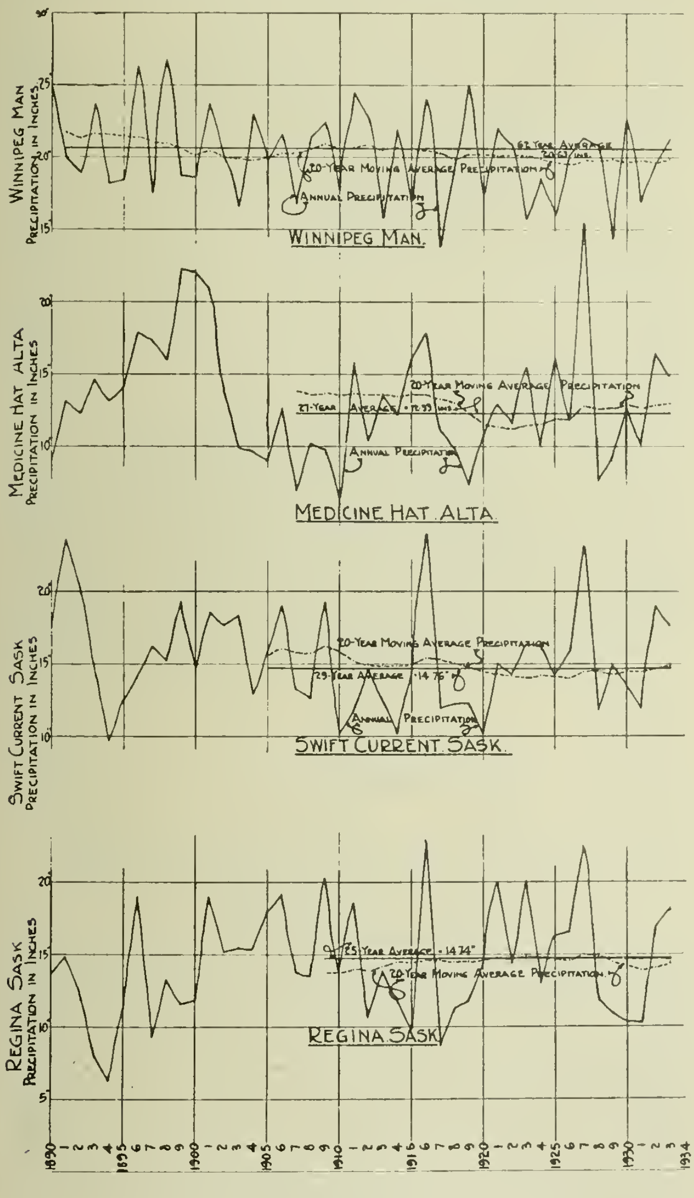

Fig. 2—Total Precipitation from 1890 to 1933.

Now temperature is the most important factor in evaporation. According to Meyer[1] it appears that the rate of evaporation doubles for an increase of approximately 18 degrees F. other factors remaining the same, hence we may assume that the increase of 3.9 degrees F. in Winnipeg represented an increase of approximately 21.6 per cent in the rate of evaporation.

1 Elements of Hydrology, by A. F. Meyer, Wiley, New York.

Sunspots and Run-off

While the relation between sunspots and precipitation is very difficult to trace in a continental climate, there seems to be an actual association between sunspot count and stream discharge.

Figure 4 shows the apparent connection between the sunspot cycle and the discharge of the Red river at Emerson. It will be noted that the sunspot culminations are high and low alternately; that there is a high river discharge one year before all sunspot maxima, also three to four years after the high peaks, but not after the low ones.

This apparent relation was particularly interesting during the period 1901 to 1913. The sunspot cycle should have attained its maximum in 1906. Actually two summits of approximately equal intensity appeared in 1905 and 1907. It seems more than coincidence that the river discharge was high in 1904 and 1906, just a year prior in each case to the two unexpected sunspot maxima.

It is possible that this phenomenon is not due to increased precipitation but rather to reduced evaporation, or possibly more effective precipitation, either of which would provide more water for run-off.

The above offers an interesting field for further investigation. It must be admitted, however, that in Canada, and particularly in western Canada, such work is greatly handicapped due to the comparatively short periods during which records have been kept. Further, our records, meteorological and hydrometrical, leave much to be desired. For example there are no continuous humidity records; wind velocity is only recorded at one elevation, and not frequently enough to make it worth while. The object of stream measurement seems to have been to get a ten-year average. Usually, on minor streams, measurements cease after this has been obtained. Many fairly important streams have not been measured at all.

This is not a criticism of the several departments that are responsible for collecting such data, as no doubt they are doing the best they can with the funds at their disposal.

Temperature, Precipitation and Run-off

The effect of temperature, precipitation and other factors on the discharge of the Red river can be observed in Fig. 5. All records are on a twenty-year moving average basis, and in order to be comparable, have been calculated as a percentage, using the twenty-year period ending in 1910 as 100 for all three phenomena.

Temperatures rose more or less steadily from 1901 to 1931, and precipitation tended to increase during the period 1902 to 1909. River discharge during this period, and until 1910, increased in sympathy with the increase in precipitation, and in spite of increase in temperature, because the rate of effective precipitation increase was apparently greater than that of temperature. From 1910 to 1919 precipitation on the average changed very little, but river discharge was reduced, apparently due to increased evaporation. Since 1919 temperatures have continued to climb and precipitation to lower on the Red river drainage area, while the river discharge, due to these two unfavourable factors (and probably to others such as increased demand of vegetation) has quickly been reduced until for the twenty-year period ending in 1933 it was only 63 per cent of that recorded in a similar period ending 1910.

It will be seen from Fig. 3 that since 1931 temperatures have been coming down. 1934 will lower this graph still further. It seems probable that there is a more or less definite temperature cycle and that 1931 was the top of the curve. Thus lower temperatures are likely over a fairly long period of years, and therefore lower evaporation, and hence more moisture for the growing crops.

In Fig. 4 the sunspot cycle and discharge in the Red river have been forecast up to 1945 using the same pattern that has occurred in the past. The probabilities are that the sunspot curve will approximate that forecast, and that the river will also more or less follow the pattern it has followed in the past. But in order for the river to do this, a great deal of precipitation must be received during the next three years, and a considerable amount for three or four years after the maximum sunspot year of 1938. The water table is now low and one year of heavy precipitation would have little effect on stream flow.

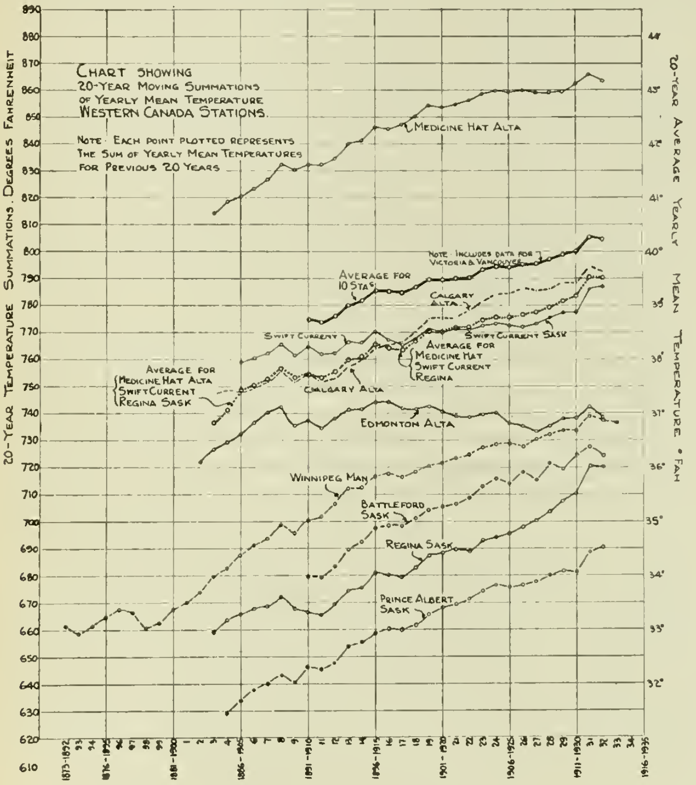

Fig. 3—Twenty-Year Moving Summations of Yearly Mean Temperature.

Importance of Water

A high standard of living without the provision of a plentiful water supply of good quality is out of the question. Most engineering work is concerned with water; either getting rid of it, harnessing it or conserving it. A city or country with a restricted water supply is a city or country of restricted growth.

An outstanding feature of the prairie provinces is a shortage of water, so the conservation of this valuable commodity becomes an exceedingly important factor in any scheme for their economic improvement.

The minimum flow of the Saskatchewan river at La Corne is approximately 1,900 second-feet. As Alberta will develop along with Saskatchewan, the draught on both branches of this stream in Alberta will be heavy, hence this minimum flow will be reduced. As some water must be allowed to discharge into Manitoba, the amount available for use in Saskatchewan at minimum discharge might only be a few hundred second-feet. It is obvious therefore that some day storage of spring flow in the Saskatchewan river will be necessary.

If the standard of living improves, and people become more exacting as to the quality of water, and particularly as irrigation is extended (as seems inevitable), this minimum flow, plus the conveniently usable ground water, will not do more than take care of the present population; hence, any increase in industrial activity, or population, or both, will mean that some part of the flood waters of the Saskatchewan river, and other streams, must be conserved.

It would seem then that the population of the prairie regions, say south of the 54th parallel, may ultimately be limited by the amount of water that can be conserved rather than by the amount of food that can be produced. It may be noted that up to the present the average production of cereal products in Saskatchewan alone has been sufficient to furnish a population of at least forty million people with that important part of their daily ration.

Standard of Living

A striking paradox in this land of plenty, potentially one of the wealthiest countries in the world, is the present disparity in the standard of living as between urban and rural citizens. The standard of living on many farms of the prairie provinces is much too low; lower in many respects than that of the peasantry of Europe. The latter at least enjoy a community life, social intercourse, the æsthetic advantages of trees, streams, lakes and natural or artificial beauty in many forms. These, for the most part, are denied to the denizens of our western prairies.

Modern methods of farming, where one or two men with the aid of machinery can cultivate at least half a section of land, tend to produce a scattered rural population, not dense enough to sustain an interesting community life. Lack of good drinking water is a hardship; lack of sufficient water for stock, in many large areas, compels the farmer to concentrate on cereal crops. A sparse population makes it economically difficult to provide electric energy, water, rural mail delivery, playgrounds, community halls and other amenities or services, common to denser rural populations, and of course to urban communities.

Housing conditions in some portions of the prairie country are exceedingly bad. Apparently the settlers in general did not appreciate the importance of having good homes and pleasant surroundings. The craze for more land of course had something to do with this tendency, but undoubtedly the uninviting appearance of the "bald-headed prairie" created in settlers the feeling of temporary tenure.

The standard of living must be raised if we are to have permanent settlement of desirable citizens on a large scale in this vast area.

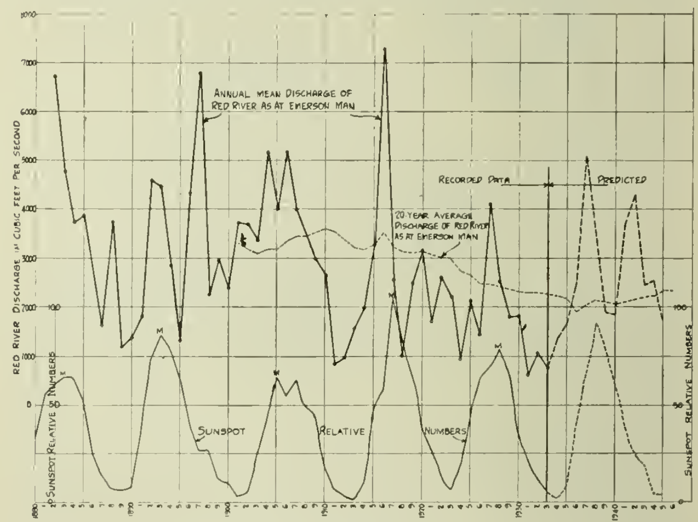

Fig. 4—Flow of Red River at Emerson, Man., and relative Sunspot Numbers.

Living conditions could be greatly improved by conserving surface water; by forming artificial lakes and by creating water districts to serve rural communities with that precious commodity in much the same way as urban communities are now served.

Utilization of Water

The average precipitation in the country considered is between 15 and 16 inches per annum. The final run-off, after deducting amounts that must be allowed to discharge in the United States and Manitoba, represents approximately 3 inches over the adjacent territory suitable for mixed farming. This would indicate that irrigation on a large scale is out of the question.

There is too much tendency to think of western Canada in terms of wheat. If present methods of farming continue, very little increase in prairie population can be expected. Producing large quantities of wheat alone on the prairies may help the growth of population in eastern Canada and possibly in British Columbia, but does not tend to increase population greatly in the prairie provinces.

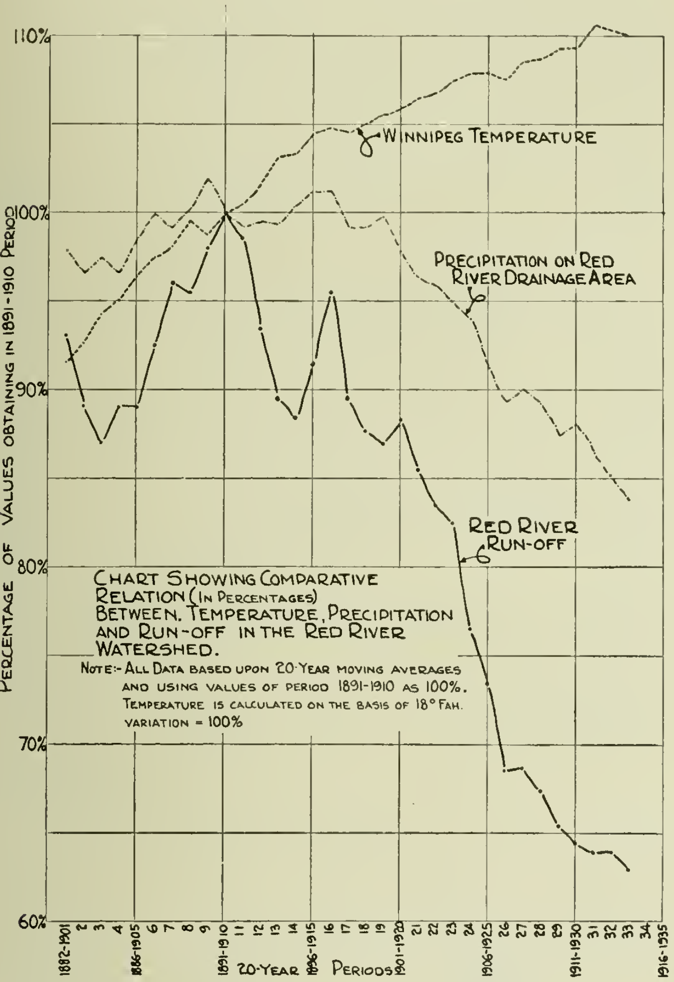

Fig. 5—Relation Between Temperature Precipitation and Run-Off in the Red River Watershed.

It is the author's opinion that available water should not be used for wheat irrigation. Indeed the prairie soil produces excellent wheat without irrigation. It is suggested that an ideal arrangement would be to provide water under pressure say along each alternate north and south, or east and west, road allowance, in a given water district. Water would be furnished first for domestic use in the home, thus tending to raise the standard of living; secondly, it would be piped to the barn and elsewhere for the use of stock; thirdly, water would be available for say an acre or two of garden, providing vegetables for home consumption and for sale, and roots for hogs, etc. Fourthly, sufficient water should be made available for irrigating from 15 to 25 acres of hay land per quarter section. Thus a farmer and his family on half a section could produce say 100 acres of wheat annually. When the market for wheat was poor, or in the event of a periodical drought, they would still have their garden truck, a few head of stall-fed beef steers, some fat hogs, poultry, eggs, milk and cream to carry them through. Even in the event of a depression, when such produce is difficult to dispose of at a profit, they would at least have enough to eat and so would not be a burden on other taxpayers for relief, as at present.

The tragedy of the drought area is not that farmers failed to produce large quantities of wheat; indeed it was a godsend in disguise that they did not do so, as the world supply was apparently too great. The sad part is that they had nothing to eat, chiefly due to lack of water for stock and for growing vegetables for themselves and feed for cattle, hogs, and poultry. Under the system proposed above, water would be available in the cities, towns and hamlets, as well as in the rural areas, and it is calculated that on the average 120 acre-feet of water per annum for each section of land would supply the rural requirements.

Economics of Rehabilitation

Seventy-five per cent at least of the rural population of this vast area, with their horses and machinery, have been practically idle for several months each summer for two, three and even four years. If this power could have been utilized during that period, all the projects suggested below, and many more, could have been completed, and each completed project would have added to the real wealth of the nation.

As it is the residents have remained in idleness, much against their will, and millions of money have been poured into these areas for relief purposes for which there is no added wealth to show. Further, during this period, the people to some extent have lost their moral fibre and independence.

It must be admitted that our economic system justified the course we have followed, so we have at least been consistent; however, in the opinion of the writer, any economic system that prevents needed projects being constructed when otherwise idle labour, willing and anxious to work, is available; when a large proportion of the material required for such improvements is at hand, and the balance available in other parts of the country where using it will provide work for other idle people, and when the alternative to doing such work is to keep the idle people on relief at the expense of taxpayers; then that system of economics should be overhauled as there must necessarily be something basically wrong with it. This is not a plea for either socialism or fascism but rather for common sense.

It may be argued that the above discussion is departing from the realm of engineering for that of economics. Engineering cannot be divorced from economics and it would seem that engineers, whose bounden duty is to serve mankind, should be jealous of anything that prevents or weakens that service.

Specific Water Conservation Projects

To indicate the possibilities and limitations of water conservation in the prairie country, a few specific projects will be discussed. These proposals are marked on the map in Fig. 6. They were studied by the author during a reconnaissance trip made for the Saskatchewan government in 1931. As no field work was done, the description in each case is necessarily a general outline of possibilities. As no such reconnaissance was made either of Alberta or Manitoba the following schemes suggested for further study are limited to Saskatchewan. One major project only will be mentioned.

The average annual discharge of the South Saskatchewan river at Saskatoon is approximately eight million acre-feet, or over twelve times as much as the aggregate of all the other central and southern Saskatchewan streams. This is a measure of the relative importance of the South

Saskatchewan river and the other streams. In other words this large stream must be tapped if any considerable portion of the drought area is to be provided with water. The other streams are important enough locally, but even if all of them were developed, only a relatively small proportion of the country would be benefited.

The amount of water which can be taken from the South Saskatchewan river depends on negotiations with the adjacent provinces, the desire of the people for water and their ability to solve power and economic problems.

Riverhurst Proposal

It is worth while studying the possibility of holding about 100 feet of water on a dam across the South Saskatchewan river near Riverhurst. It appears possible here to develop enough power from such a dam to lift say one million acre-feet per annum into a reservoir in the Vermilion Hills where the head would be sufficient to discharge water to the international boundary, say south of Estevan. This water could be used for the cities of Moose Jaw, Regina, and Weyburn; for the numerous towns and hamlets in this region and for farms. If this were done an area of approximately 10,000 square miles would be served with excellent water. Each section of land to which water is served should of course bear part of the cost; on the other hand as the community itself would be wealthier because of available water, it should also bear part of the cost. Again the economics of this proposal should be viewed from the standpoint outlined above, where it was shown that labour is going to waste now and should be harnessed.

Cypress Lake Project

For many years the advisability of holding water in Frenchman river, just north of Robsart, and irrigating the Robsart-Vidora areas, has been under consideration. A combination scheme of diverting some water from Battle creek into Cypress lake, holding here with a small dam and having a main dam north of Robsart on the Frenchman river, has also been suggested. As the country has a very definite fall to the south and east from the site of the proposed dam there would be no need for pumping if the water were carried to farms by pipe lines instead of ditches. Furthermore, maintenance costs would be very much less. On the basis of providing 120 acre-feet per annum to each section as already suggested, a large area of this part of Saskatchewan would be made more or less independent of drought as far as normal living is concerned. Again, this area produces some very fine wheat crops without irrigation.

Swift Current Creek

Since 1931 Rush Lake and Morse Lake have been dry, while Lake Chaplin probably has not more than one-tenth of its normal volume. The last mentioned lake gets very little water from the surrounding country but is dependent almost entirely on overflow from Lake Johnston. When dry seasons come, Lake Johnston is able to hold the total discharge of Wood river, so there is nothing left for Lake Chaplin. The normal area of this latter lake is about 22 square miles. Surrounding the lake, and to the south east of it, there is at least an equal area that is so low and marshy that it also should be classified as lake bottom.

It is proposed to divert practically the total discharge of Swift Current creek into Rush Lake creek about 2 miles north and 3 miles east of Waldeck. This would be accomplished by constructing a relatively small diversion dam on Swift Current creek and tunnelling through the ridge to the east. There is a fall of about 35 feet between the two streams, Rush Lake creek being the lower of the wo. Normally there would be sufficient water to raiset Rush Lake 3 or 4 feet and Morse Lake about 5 feet. During wet years the surplus water can be stored in Lake Chaplin.

It is expected that sufficient water would be available to maintain the three lakes with the following area at least:—

Rush Lake	7 square miles
Morse Lake	14 " "
Lake Chaplin	32 " "
Total water area	53 square miles

Fig. 6—Suggested Water Conservation Projects in Saskatchewan.

This is probably 45 square miles more water area than at present.

Of course it might be better to use this excellent water for domestic use for stock and for irrigating gardens and small areas of alfalfa as described elsewhere. Some 600 square miles of mixed farming country could be salvaged in this way; however, the country needs the water areas described, and serious consideration should be given this proposal before the alternative, or any other scheme, is agreed to.

The pond ducks and other water fowl of this continent are decreasing, due partly to the scarcity of prairie sloughs and lakes for suitable breeding grounds, and partly to bad water conditions in lakes that have not yet dried up. It must be remembered that the solid matter in solution changes in inverse ratio to the change in volume of water, up to the point of saturation. As some of our prairie lakes now contain from one-quarter to one-tenth of their normal volume, their saline content must now be four to ten times as great as formerly.

As this particular project would add a greater water area suitable for prairie waterfowl than any other suggested, it is probable that the water should be used for this purpose.

Buffalo Pound Lake Project

The Qu'Appelle river is one of the larger streams whose flow at present is of very little value to the country. In the early spring it often goes in flood, damaging much property along its valley and causing high water in the Assiniboine river, thus being largely responsible for the flood damage between Brandon and Winnipeg. In other seasons of the year it is often dry as far east as the Manitoba-Saskatchewan boundary.

It is proposed to construct a dam across the Qu'Appelle river immediately below its confluence with Moose Jaw creek. This reservoir would be capable of impounding the total flow in any one year of Moose Jaw creek and the Qu'Appelle river up to that point. A lake would be formed in the Qu'Appelle valley some ¾ mile wide and 24 miles long, flooding out Buffalo Pound lake which has been practically dry since 1931.

The advantages of such a proposal are many. Between 6,000 and 8,000 acres of excellent sandy loam land in the Qu'Appelle valley could be irrigated by gravity from the proposed reservoir. As this area is adjacent to good markets in Moose Jaw and Regina, no doubt it would develop into a vegetable and small fruit growing district, for which it is exceptionally well fitted.

Floods in the Qu'Appelle valley would be prevented and a beneficial effect on the flood conditions in the Assiniboine may be expected. Low water flow in both the Qu'Appelle and Assiniboine rivers could be increased, a boon to the settlers along their banks.

In this same project it is also proposed to improve the small dam at Craven and construct another on the outlet from Long Lake. By so doing Long Lake can be maintained at a pre-determined level, thus improving an already popular summer resort.

The several other beautiful lakes along the Qu'Appelle valley below Craven would be kept full also, which would be a source of pleasure to the people of the lower valley. Buffalo Pound lake itself would provide a summer resort for boating, bathing, etc., less than twenty miles from the city of Moose Jaw.

Souris River

The Souris river has an average annual discharge of about 60,000 acre-feet at the international boundary. Nearly two-thirds of this passes through the valley during six weeks in the spring. The city of Minot, North Dakota, is interested in the conservation of water in this stream, as it would help to prevent floods in spring and to increase low water flow, chiefly for the dilution of sewage.

Tentative offers of contributions towards the cost of controlling the Souris river in Saskatchewan have been made by representatives of the city of Minot and the state of North Dakota.

By damming the Souris river itself some three miles west of Estevan and its two chief tributaries, i.e., Long creek and Moose Mountain creek, at Estevan and Alameda respectively, the flow of the Souris river could be entirely controlled.

As this portion of Saskatchewan is underlain by thick seams of lignite coal, while clay for brick making and other purposes is close at hand, it is probable that the available water should be conserved chiefly for industrial purposes.

If the Souris river and Long creek near Estevan are dammed, sufficient water would be impounded to provide for steam plants of several hundred thousand horse power; considerably more than southern and central Saskatchewan will require for many years in the future.

The water impounded in Moose Mountain creek near Alameda could be used for farm purposes as described elsewhere. Water is urgently needed for this in the district around Frobisher, Oxbow and east, at the present time, which is an excellent wheat growing country.

Many other projects could be mentioned, particularly for preserving at a high elevation many of the larger lakes, such as Big Muddy, Willow Bunch and Goose Lake; all of which are practically dry at the present time. Such projects would raise the level of the ground water table in their general vicinity; would provide water for cattle and other stock, breeding ground for water fowl, recreational areas for residents, and would in general make the prairie a more desirable country in which to live.

Ground Water

Too little is known about the ground water resources of the three prairie provinces. Farmers, engineers and others are wasting a great deal of money and effort in costly experiments trying to find satisfactory ground water in various parts of the country.

A comprehensive report on the geology and ground water resources of the prairie provinces should be prepared. While some information is already obtainable for isolated areas, it is inadequate as a basis for rehabilitation projects. The farmer, industrialist or engineer should be able to tell directly from such a report where water is obtainable, the quantity, quality and probable depth at which it will be found.

It may be stated however that our ground water resources in this territory are not very impressive. Very few important artesian areas exist. For the most part also the quality of ground water is far from satisfactory.

Professor Simpson has given one hundred and ninety-six analyses of typical ground waters in North Dakota.[2] Comparing these with the specifications for drinking water issued by the United States Treasury Department, it is found that only 2 per cent are good, 11 per cent fair, 11 per cent poor, and 76 per cent unfit for human consumption. About the same ratio holds in general for the prairie country in Canada.

While a great deal of improvement can be made in the quality of these ground waters by suitable treatment, many cannot be made potable, due to heavy concentration of the sodium salts.

This is another reason why surface supplies should be developed to the fullest extent possible in our prairie country.

Conclusion

Drought conditions are serious in the prairie provinces. The area affected is getting larger. While natural factors

2 U.S. Geological Survey, Water Supply Paper No. 598.

appear to be changing for the better (i.e., increased precipitation and lower evaporation), man must take action to rehabilitate the stricken country and to create conditions that will minimize the effects of another serious drought period when it comes, as it surely will. Much depends on the technical agriculturist in developing more suitable vegetation and farming methods; much depends on the farmer in using these weapons and others intelligently and energetically. A great deal can be done by intelligent forest protection, reforestation, afforestation and the planting of hedges, etc. Perhaps the largest amount of responsibility lies with the engineer in connection with the conservation and utilization to the best advantage of all available surface and ground waters.

The problem as a whole is one that cannot be solved by the engineer alone, or the agronomist, or the forestry expert, but rather by a small commission of technical men co-ordinating the work of government departments, universities and private individuals.

In conclusion an excerpt is quoted from an article written for the author by Mr. J. Dewey Soper, Chief Federal Migratory Bird Officer for the western provinces, which shows how important such proposals are from the standpoint of bird life on this continent.

"Drastic steps are required to save both the farming interests of the dry belt and the waterfowl which one day so abundantly populated its innumerable ponds and sloughs. The time has come for a profound consideration of these problems. Drainage operations must be abolished and every effort made to restore vanished lakes and suspend the gradual subsidence of others—if that is at all possible. The restoration of ponds, lakes and sloughs, and the planting of trees should go far to bring back a normal farming community, and coincidentally the waterfowl population. Tree belts, while preventing the devastating effects of soil drifting and conserving moisture with a heightening of the water table, will attract a great army of insectivorous birds beneficial to agriculture. *Upon an adequate and prolonged restoration programme will hinge important inter-related and profitable consequences.*"

Storage on the South Saskatchewan River

Walter Blue, A.M.E.I.C.,
Manager, Development, Gatineau Power Company, Ottawa, Ont.

Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

During the past four years parts of southern Manitoba and sections of southeastern Alberta, and particularly southern Saskatchewan, have suffered from a severe drought, with a consequent loss and hardship to the inhabitants in particular and to Canada in general. To relieve this situation, the various governments have been providing relief in the form of money, food and clothing. While this method may be the most economical, it will not prevent a recurrence of the present situation and it is now realized that measures for the conservation of the water supply in the prairie provinces will have to be taken before any permanent relief can be effected.

Sources from which water might be drawn for irrigation in southern Saskatchewan are the streams rising in the province and the South Saskatchewan river.

It has been suggested that many small local reservoirs should be built to conserve the spring runoff of streams having their sources within the drought area. The writer has not sufficient knowledge of the country to say how feasible this would be, but it is quite apparent that this supply is not dependable. The chief source of supply must therefore be from streams having their source and main water supply outside of the area affected. The Saskatchewan river fulfills this condition, as about three quarters of its flow is of glacial origin from the Rocky Mountains. The precipitation in the prairies adds little to its flow.

The Saskatchewan river is one of the largest in western Canada. Both its north and south branches rise in the Rocky Mountains and flow easterly through the provinces of Alberta and Saskatchewan, the south branch through the drought area, joining about thirty miles below Prince Albert at the Forks, then continuing east and north to The Pas, Manitoba, finally emptying into Lake Winnipeg. The construction of a storage dam on the south branch warrants serious consideration, and while it would not relieve the whole drought area, it would have the decided advantage of providing permanent relief each year to over 800,000 acres of dry land. Other benefits attributable to storage will be mentioned later.

While it is impossible, without more information to decide definitely on a location for the dam, a study of reliable contoured maps indicates that a site in the vicinity of The Elbow, or upstream from it, depending on where the lands are that require irrigation and can be irrigated, would have many advantages. As an example, if a dam could be constructed on the South Saskatchewan river, below its junction with Aiktow Creek, the natural level could be raised about 140 feet from elevation 1650 to 1805, and the deeply eroded valley of the South Saskatchewan river used as the storage reservoir, having a capacity of 200 billion cubic feet. If this location were finally chosen, a secondary dam would have to be constructed on the height of land between the waters of Aiktow Creek and the Qu'Appelle river, and a third at the outlet of Buffalo Pound lake, creating a supplementary reservoir having a capacity of 115 billion cubic feet to elevation 1775, would make water available in that valley for irrigation, grazing and water supply. This supplementary reservoir would be filled by the excess of the requirements for 200 billion cubic feet.

The total drainage area at the mouth is 155,000 square miles, and at The Pas 149,000 square miles. The drainage area at Saskatoon, situated on the South Saskatchewan river, with which branch this memorandum mainly deals, is 50,900 square miles.

The records of stream flow at Saskatoon for the South Saskatchewan have been kept by the Dominion Water Power Branch since 1911 and show that the river at this point has a discharge varying from a minimum flow of 765 to a maximum of 131,000 second feet, or a ratio of 1 to 170.

A calculation, using the monthly mean flows for the period 1911 to September 1933 indicates that there has been sufficient water in the river to fill annually a storage reservoir of 200 billion cubic feet, based on the lowest period of record. This water so stored and the flow regulated as required would have been enough to irrigate 800,000 acres of land each year, at the rate of 3 feet per acre, and, in addition, would have increased the low flow of the river from a monthly minimum of 1,300 second feet to 4,000 second feet, as well as increasing the low flow of the Qu'Appelle river by some 400 cubic feet per second, or more, and providing sufficient water for a population double the combined population of Moose Jaw and Regina.

The flows of the South Saskatchewan and the Qu'Appelle rivers are entirely dissimilar. The South Saskatchewan at Medicine Hat has a drainage area of 20,600 miles and on the Qu'Appelle at Tantallon, 120 miles east of Regina, the drainage area is the same. An examination of the monthly mean flows shows that in April 1925, when the South Saskatchewan at Medicine Hat was flowing 11,600 cubic feet per second, the discharge on the Qu'Appelle was only 1,950 cubic feet per second. For July of the same year, the flow of the South Saskatchewan at Medicine Hat was 10,600 and the Qu'Appelle 250. In July 1926 the flow at Medicine Hat was 7,340 and on the Qu'Appelle, 76.

The Qu'Appelle flows just north of Moose Jaw and north of Regina. Both these towns draw their water from wells. An increased flow in this river would give assurance of a constant increased supply of water for these two cities and to the lands along its route.

A scheme was proposed some years ago for the pumping of water from the Saskatchewan river over the height of land down Thunder Creek valley, for a water supply to Moose Jaw and Regina by the construction of a small storage dam on this river.

With the larger scheme of storage on the South Saskatchewan, as proposed by this memorandum, it might be possible to extend pipe lines or canals and supply water to smaller storage reservoirs located throughout the affected area.

From the standpoint of reclamation, it is reported that in the Carrot river triangle and the Pasquia river section, upstream and downstream from The Pas, an area of land exceeding one million acres is annually inundated by the flood waters of the Saskatchewan river. It is nearly impossible, from an economic standpoint, to create sufficient storage to totally store peak flows and reduce them so that they would never occur, but the creation of storage does reduce the duration of peak and so would assist in reclaiming this huge area.

While some power for pumping could be developed at the storage dam itself, the variation in the head would be a serious factor and it is quite probable that power would need to be developed at plants downstream from the storage dam where the head would be constant and the minimum flow greater.

The increase in the potential power of the river, due to the storage, from the probable dam site down to a point about 150 miles upstream from The Pas would be about 200,000 h.p. at 100 per cent load factor and 85 per cent efficiency. Some of these sites are a considerable distance below the proposed storage reservoir, but with proper operation and the succession of ponds caused by the power developments, nearly the full effect of the storage would be obtained at the lower sites.

The construction of power plants primarily for pumping would not interfere with existing power systems. At certain times during the year there would be power available for sale. The population of Saskatchewan is some 951,000, the third largest of any province in Canada, and yet, possibly due to the lack of large manufacturing industries, the power at present developed by plants having power for sale within the province is only 126 h.p. per 1,000 of population. The developed power within the province consists of water power 42,035 and power developed by some 140 odd fuel oil and steam stations, amounts to some 78,400 h.p. Practically all of the water power is produced in the plant on the Churchill river, and is exported to Manitoba for use in the mines.

The above figure of 126 h.p. per 1,000 of population appears to be far from the saturation point. Ontario has 668 h.p. per 1,000 of population, Manitoba 541 h.p. per 1,000 and British Columbia over 1,000 h.p.

Similar storage schemes can no doubt be built on the North Saskatchewan, the Red Deer and other tributary streams rising in the mountains, with consequent benefits to irrigation, reclamation, water power and navigation.

At the present time, irrigation is of paramount importance. The other uses for water mentioned above should not be lost sight of in future plans, and it is felt that the scheme suggested by this paper also serves these other three demands.

A complete inquiry should be made as to the economic possibilities of relieving in part the drought by irrigation and no scheme should be gone ahead with until a thorough examination has been made of the water resources of the Saskatchewan river drainage area. As the river is interprovincial, a committee might be formed consisting of a proper member from each of the provinces affected and from the Dominion government to report on the construction of a storage dam or dams to benefit irrigation, reclamation, power and navigation. If it was decided that storage dams were the proper practical solution, a legal agreement could be entered into between the three provinces and the Dominion, based on their respective rights, to carry the project to a successful conclusion.

Water Phases of the Drought Relief Programme of the United States Federal Emergency Relief Administration

Lewis A. Jones, Staff Engineer,
Federal Emergency Relief Administration, Washington, D.C.

Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ontario, February 7th and 8th, 1935.

In June 1934 the Congress of the United States made available to the Federal Emergency Relief Administration the sum of $525,000,000 to be expended on drought relief in areas designated by the U.S. Department of Agriculture as suffering from drought, the funds to remain available until March 31st, 1935. The Federal Emergency Relief Administration allotted these funds to the various State Emergency Relief Administrations in the drought area to be expended by these agencies under general policies established by the Federal Administration.

A number of states have set up State Planning Boards or State Conservation Boards each having a federal representative associated with them. These federal representatives are expected to assist in co-ordinating the work of the various state boards with the plans of the National Resources Board working under the Public Works Administration. In some states the State Committees are called State Planning Committees and in others State Conservation Boards or Committees.

The programme as carried out has included all types of relief such as direct payment of funds to distressed families, the purchase of livestock that could not be maintained in the drought area because of shortage of feed and water, the furnishing of seed for late forage crops, etc., and work projects such as the processing and canning of meats for distribution to people on relief rolls and the development of water supplies in the drought areas.

Because of the comparatively short time the drought relief funds would be available, and the urgent need in many areas for immediate water supplies, it was decided in planning the water programme to limit the work to projects that would promptly make water available, and that could be completed within the limited time during which drought funds would be available. In other words, the object was to meet the existing drought situation rather than to start on a long time water conservation programme.

On the national forest ranges and public grazing land the work has been confined largely to the cleaning out and improvement of springs, the digging of wells, the furnishing of windmills and tanks, and the construction of dams to form stock water holes. The improvements are more or less of a permanent nature and the increased carrying capacity of the range resulting from the work will ultimately pay the cost.

On privately owned land, both in the range and dry farming areas, the same types of projects have been carried on, but in every case before construction work has been started, the landowner has been required to sign an easement granting the general public access to the water developed during periods of drought.

In the irrigated areas ditches have been cleaned out and lined to reduce seepage losses, reservoirs and other irrigation structures have been repaired, small reservoirs have been constructed and pumping from streams has been carried on to furnish supplemental water for crops. This work has resulted in the saving of large areas of crops that would have otherwise been killed by the drought, and has enabled the landowners to take care of themselves during this winter instead of being dependent upon the relief rolls. The cost of carrying the benefited people over the winter on the relief rolls would have in most cases exceeded very materially the cost of the work and the landowners have been able to maintain their self respect.

In some instances the water supplies for towns and villages have been supplemented by the digging of wells, the improvement of reservoirs, the construction of pipe lines and the pumping of water from nearby streams, etc. In practically all cases where assistance has been rendered to incorporated towns the local communities have been required to furnish most of the materials required for the work, and the drought funds have been expended in the employment of labour that would otherwise have been on the relief rolls.

In a few of the drought states bird refuges and recreational lakes have been developed as a phase of the relief work, the size of the lakes varying in area from about 80 to 10,000 acres. The bird refuges have been developed on public lands and entirely at public expense. In developing the recreational lakes the local people have been required to furnish the lake site and all or part of the materials and equipment required for the work. The relief funds have been devoted primarily to the employment of labour from the relief rolls. In visiting the field the writer has been impressed with the popularity of such developments. They appeal especially to the residents of the semi-arid states where bodies of water for recreational uses are non-existent.

In addition to the construction projects outlined above a number of the State Relief Administrations have conducted ground and surface water surveys to determine the extent of such resources. Such projects have furnished employment to engineers and geologists in need, and the results obtained will be of great value in planning long time programmes of water conservations. Several of the states have established Water Conservation Boards and the State Relief Administrations have co-operated with these boards by furnishing technical personnel to assist ni developing state-wide plans for water development. If a general public works programme should be undertaken the plans that have been prepared will be of great value in expediting the work.

In Montana the water programme has been limited primarily to the development of water supplies on the range lands. Numerous springs have been cleaned out and equipped with suitable water troughs; wells have been dug; and small dams constructed to form stock water ponds. As a result of the work it has been possible to retain a large amount of livestock in the state that would otherwise had to have been sacrificed. In some instances supplemental water has been made available to irrigated lands and repairs made to irrigation systems to reduce seepage losses. Assistance has also been rendered to the State Conservation Board by furnishing employment to technical employees engaged in developing a long time plan of water development and conservation for the state.

In North Dakota work in the rural region has been limited primarily to the construction of dams for stock water ponds. It is expected that more than four hundred such dams will be completed before the end of next March. In addition to the stock water ponds a considerable number of small recreational lakes and municipal reservoirs have been completed ranging in size from 30 to 40 acres up to 600 or 700 acres. Five large bird refuges are also under construction covering a total of more than 150,000 acres. The refuges on the Des Lacs lakes and the Souris river, located north of Minot, are expected, when completed, to be the most valuable wild life refuges in the United States. In localities where municipalities and rural communities have suffered from shortage of water, wells have been dug to relieve the situation.

The state has organized a Water Conservation Board and the Emergency Relief Administration has co-operated with the board by furnishing technical personnel from the unemployed lists to conduct a state-wide survey of ground water conditions which will be of value in planning a water development programme for the state.

The Federal Emergency Relief Administration feels that the water development and conservation projects carried on under the drought relief programme have not only been of great value in relieving the immediate drought situation but that much of the work is of such permanent character that benefits will continue to be derived for years to come. The value of the crops and livestock saved during the past season have enabled large numbers of farmers to maintain themselves who otherwise would have had to appeal for relief during the present winter. The reduction thus obtained in the relief load will go a long way toward paying the cost of the work. The programme has also provided an opportunity for work to large numbers on the relief rolls, thus enabling them to maintain their self respect by working instead of accepting a dole.

Under the Public Works Programme it is planned to plant a shelter belt extending from north central North Dakota south into the state of Texas. The belt is to be made up of strips of timber a few hundred feet wide placed a mile apart, the entire belt having a total width of approximately 100 miles. It is expected that $25,000,000 will be available for the work during 1935. Planting will be started this spring and it is expected that all of the tree stock available will be planted. Nurseries will be started to supply further stock for the belt.

The National Resources Board has prepared a long-time programme of the development of National Resources that it is expected will be used as a guide in planning for public improvements under plan of Public Works passed by Congress. Congress is now engaged in considering what shall be spent on public works in the immediate future. Final action has not been taken so that it is impossible to advise what authority will carry out the work that is authorized.

The Water Supply of the Prairie Provinces and its Bearing on their Economic Development[1]

DISCUSSION

S. G. Porter, M.E.I.C.—*Chairman*[2]

The criticism is sometimes made that The Institute is indifferent to the actual, the practical economic problems that the country has to meet. However, the arrangement for this discussion should tend to remove any ground for such criticism. The question under discussion is one of pressing economic concern, as well as having its engineering and scientific phases.

All of these papers are on the one general topic of the water supply of the prairie provinces and their bearing on economic development and with the discussions will form an accumulation of data and ideas that should be of practical assistance to our governments or other bodies who are interested.

H. G. Cochrane, A.M.E.I.C.[3]

The problem Mr. Main presents is, not how to grow more wheat, but how to make this area more habitable, and to conserve the investment already made in it, so that it will not eventually be given back to the Indians.

No "blanket remedy" can be applied to the drought area. Different districts require different treatment. Nor can the remedies be put into effect at once, or on a large scale. There must be piecemeal application.

The question has three aspects—social, economic and engineering, and must be considered from all three.

It appears that the various governments at the present time have neither the funds nor the inclination to make an exhaustive study, nor does an undertaking of this kind appear sufficiently attractive to private capital to warrant a private investigation of its possibilities. But viewed as *a measure to salvage investments already made*, the matter assumes a different aspect.

Who are the investors chiefly interested? Primarily, the railway companies, the insurance companies, loan and mortgage companies, grain and elevator companies, the larger merchants, farm implement companies, the larger cities and towns in the drought area. And if the list were broadened to include other bodies interested in the question, the names of the Canadian Chamber of Commerce and the Canadian Manufacturers' Association might be added.

Were these bodies approached, it is probable that all or many of them would be willing to contribute sufficient funds between them to enable a thorough consideration of the question to be carried out. Moreover, by the time such a study or appraisal were completed, it might readily be that the governments would be in a better position to take such steps as might be found necessary and recommended by such a study.

There are almost unlimited sources of information and statistics available for such an appraisal. The universities, agricultural colleges, experimental farms, grain and elevator companies, city water departments, all have statistics bearing on the subject. Crop statistics are available from the railways, and from the existing irrigation districts in operation in Alberta, the Dominion Water Power Branch and the Provincial Natural Resources Departments have available sufficient engineering surveys to form an intelligent basis for preliminary estimates. This collection of data and the consideration of it, could be undertaken and substantially completed in a preliminary way, within a year or eighteen months, with an expenditure of a few thousand dollars. Each of the variously proposed remedies could be considered one at a time, estimates of costs made, delimiting the area under consideration, and an approximate assessment made of the economic and social benefits to be gained. Even the social benefits can be partly valued by determining the amount of "relief expenditure" to be saved. Each project could be examined to see to what extent it might be self-liquidating and how.

The Engineering Institute deserves praise for bringing this question into the limelight of professional discussion. But if it merely draws such comments from its members as "Very interesting problem, someone ought to do something about it!"—nothing much will have been accomplished.

The following suggestion is therefore presented—that a strong committee of The Institute be formed at this meeting, composed mostly of its western members, empowered to approach the bodies above suggested, for contributions, to undertake such a study and

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[1] Papers presented at the Annual Meeting of The Engineering Institute of Canada, held at Toronto, Ont., February 8th, 1935, and published in the April 1935 issue of The Journal

[2] Manager, Dept. of Natural Resources, Canadian Pacific Railway Company, Calgary.

[3] Senneville, Que.

report, within limits made possible by funds obtained, and to circularize any of the profession now in possession of any pertinent information asking their co-operation. Copies of such a report could be made available to contributors and governments, and as much publicity as possible given to the subject, through the daily press, bearing in mind that ultimately governments must provide the funds for whatever is done, and informed public opinion is the only motivating force which will cause such action.

In such a way, The Engineering Institute could materially assist in the solution of a thoroughly Canadian problem of the first magnitude.

C. H. Fox, M.E.I.C.[4]

Most of the major proposals in popular discussions seem to miss the mark and it is important that engineers should stress the necessity for an exhaustive study of the actual benefits which will be derived before any scheme is put into effect.

To refer briefly to the projects. One was the diversion of the South Saskatchewan river, close to Riverhurst, to irrigate or to be distributed over an area of 8,500 square miles, all the way down to the south boundary of Saskatchewan. That project would require a dam construction across a valley 2,000 feet wide, underlain with a considerable depth of sand and silt, at least 200 miles of main distribution with reservoirs, and in addition to that, the suggested diversion of a million acre-feet of water per annum, and elevating to a sufficient height to be used over that area would require a continuous pumping plant of 80,000 h.p. capacity. That is more than the capacity available from the Saskatchewan during a great part of the season and such a pumping plant would therefore require a capacity of about 200,000 h.p. to do the work successfully.

The elevating of such large quantities as suggested in the Riverhurst diversion is an expensive undertaking. A less ambitious plan might be to make the diversion near Elbow, following the old overflow course down the Qu'Appelle.

With regard to the suggested impounding of Buffalo Pound Lake from Moose Jaw creek area. It seems strange to suggest letting water flow out of Moose Jaw creek area and impounding it in Buffalo Pound Lake, and at the same time to suggest diverting the Saskatchewan and elevating water three to four hundred feet to be used in the Moose Jaw creek drainage area.

The total precipitation on the average in most farming districts if conserved is sufficient for ordinary needs. The difficulty is that a good deal runs off at times when there is an excess. The important thing is to retain this moisture actually on the farms. The impounding of run-off in the beds of creeks is of secondary importance, while the creation of lakes at the low levels of major stream beds is of little value.

The development of at least one or two ponds on every farm surrounded with shelter belts of trees should be encouraged. To reduce evaporation losses such ponds should be as deep and of as small an area as local conditions and cost of construction will permit.

Mr. Main's paper showed some interesting charts on temperature, but those charts were all prepared on data obtained in cities or places where the amount of radiating surface had possibly increased during the period under consideration. Has that increase in temperature been general throughout the prairie lands?

P. C. Perry, A.M.E.I.C.[5]

Mr. Main has rendered a service to the prairie provinces through his efforts to arouse public interest in conservation; however, on some points our opinions differ. His introductory remarks would imply that drainage work on the prairie is to be condemned for its adverse effect on climatic conditions, while conservation schemes may be justified, in part at least, because of their value for ameliorating climate. Those who have studied the matter carefully believe that such an attitude should not be entertained in a study of conservation.

Mr. Main states "It is an axiom of climatology that the ratio of water to land has an important effect on climate. The natural corollary is that an acre of water or marsh, in a semi-arid region, must be more valuable than an acre of high class wheat land." This is quite a sweeping statement which should not be accepted unless clearly supported by the opinions of outstanding climatologists or from evidence from actual conditions. We do agree that climatologists dwell on the importance of the ratio of land to water in as far as great land masses and oceans are concerned. Mr. C. E. P. Brooks* refers to the effect of land masses as "continentality" and all writers on climatology refer to the inland type of climate as "continental." Some writers do refer to the effect of large bodies of water but the outstanding works on meteorology and climatology do not support Mr. Main's statement. Ocean currents, prevailing winds and mountain ranges are shown to be factors which far overshadow other local conditions. Mr. A. E. M. Geddes† writes "the chief factor in determining the distribution of precipitation and also of humidity is the prevailing wind system."

[4] Engineer of Water Service, Canadian Pacific Railway Company, Winnipeg.

[5] Division Engineer, Canadian National Railways, Regina, Sask.

* "Climate Through the Ages."

† "Meteorology," page 380.

A study of actual climatic conditions supports this stand. In Florida, a peninsula projecting into the Atlantic, humid conditions prevail with annual precipitation of 50 to 75 inches. In the same latitude on the other side of the continent, the peninsula of Lower California projecting into the Pacific has an annual precipitation of 10 to 25 inches and near desert conditions.

It is certain that our prairie aridity is due primarily to the presence of the mountains and the prevailing westerly winds. Conditions which bring about the precipitation of the moisture in the air, seem to be more important to us than the conditions which put the moisture there. This is shown by the way precipitation is increased by hills, where in some cases it is 75 per cent greater than on surrounding prairie.

To make clearer the natural conditions of our sloughs and lakes, the behaviour of one large slough under observation will be described. When the G.T.P. railway line from Regina to Northgate was constructed in 1912, it passed through what was described as a "dry lake bottom" near Lampman. In 1916 this slough or marsh partly filled but the water was not retained. It was dry again until 1922 when water began accumulating. The areas and depth increased until 1927, the maximum water surface being an irregular area of about 3,000 acres. It was necessary to raise the railway grade considerably and place riprap, while some highways were abandoned. The water began to recede rapidly in 1928; the entire area was dry again before the end of 1930, and has remained dry since that time. Drainage or other artificial factors had nothing to do with the disappearance of the water from this slough.

This sort of behaviour is typical of thousands of sloughs and marshes of various sizes and many lakes. The lakes containing considerable deep water are not so greatly affected and the larger ones do not disappear entirely.

It is the writer's conviction that the drainage of such areas, where local benefits justify, does no harm to the country in general, and that the forming of additional water surfaces of this kind will not be of general value. The natural slough or lake usually forms in a wide shallow depression of saucer shape and an attempt should be made to substitute reservoirs of "cup" shape. This will mean less water surface during wet years, but reservoirs which will stand the drought periods.

Even from the standpoint of providing dependable breeding grounds and resting places for water birds, one may be justified in draining some areas while at the same time constructing artificial lakes or ponds. For both drainage and storage, one need not consider effect on climate but each proposal should be judged upon basis of direct and tangible benefit.

Surface water conservation projects may be divided into three general groups: First, the small units on local streams, such as private and municipal reservoirs. Second, larger units on local streams such as the Buffalo Lake and Souris river schemes. Third, the still larger schemes dealing with the diversion of water from the Saskatchewan river.

Mr. Main's recommendations in his paper deal with the second and third classes, but at other times he has shown the possibilities of the first class. His mention of the inferior standard of living of rural populations should also be noted, the need for water for all citizens and the desirability of providing work in rural areas, all point to the local units as the type of work which should be given preference. Provincial and Dominion legislation controlling water stipulates that domestic requirements which include water for farm stock, are to be considered first in allotting waters and the justice of such a provision is self-evident. This too would indicate that the small unit development for use of local waters must be given first place. Prior use is, and should be, a claim recognized and the supply of water for those lakes which are now improved and in use should not be restricted because of the development of other projects unless the purpose for which the water is to be diverted is much more important.

In regard to cost, it should be remembered that labour should be employed on those undertakings which will be of greatest value to the country. If the situation is carefully studied with the foregoing principles in mind, it will be found that efforts should be confined chiefly to the small unit programme, that many of Mr. Main's larger proposals are not feasible and that work on others must be deferred for many years.

E. M. Proctor, M.E.I.C.[6]

S. G. Harding, Professor of Engineering in the University of California states* three things which have a bearing on this subject and may be summarized as follows: First, within tne last thirty to sixty years the Great Salt Lake area in Utah has apparently experienced the most moist period of the last three hundred years. Second, the last one hundred years has been continuously more moist than the preceding one hundred years. Third, the period of deficient water

[6] President, James, Proctor and Redfern Ltd., consulting engineers, Toronto.

* The Civil Engineer, February 1935.

supply since 1917 has not resulted in as great an accumulated deficiency as in the past.

This may indicate that possibly conditions in Canada may still become worse.

C. H. Attwood, A.M.E.I.C.[7]

Premier Bracken has taken a keen interest in the drought problem. In fact, he has stated* that "The spectacle of shortage of food in large farming areas, and the necessity of shipping livestock away from hitherto prosperous and productive communities, and of shipping in thousands of carloads of feed for animals and scores of carloads of food for human consumption, in order to prevent widespread distress and abandonment of land on a wholesale scale—this spectacle is not a pleasant one to contemplate, and one that you and I and two million others on these plains must try as far as possible to prevent in future." . . . .

"If we are not to witness similar distress at recurring periods in the future, we must pool our brains and our experience, and in the light of past history, formulate such policies and execute such plans as will adequately meet the contingencies, which are sure to arise occasionally in the future, just as they have in the past." . . . .

"Is it better, as some have said, to let time and economic conditions determine the future of these areas at whatever price in abandoned farms and disappointed human lives? Or can we rehabilitate the vast areas now temporarily in a state of partial desert? Can we prevent a recurrence of these conditions? Can we avoid the still further encroachment of the drought area upon adjoining lands?

"These are vital questions which challenge the practical wisdom of this generation. They are a challenge to our scientific skill, to our statecraft and to our administrative ability. They are a challenge to you and to me and to half a million others directly affected in these areas."

Mr. Bracken says further: "That in approaching such a problem, it is essential first to discover the basic facts. Unless this is done, faulty conclusions are sure to be drawn from wrong premises. Opinions and hopes are a poor foundation upon which to build a structure expected to stand the storms and vicissitudes of a dry and somewhat variable climate."

He also observed that: "In my judgment some of our forestry policies, some of our drainage practices, and some of our soil management and cropping methods need reconsideration and redirection in the light of the apparently increased danger of drought.

"We have been cutting trees and burning forest; we must plant trees and protect the forests. We have over-drained some of our lands; we must commence to regulate and maintain the water table rather than to lower it further. We have tilled some of our virgin soils until we have injured their texture; we must modify our tillage methods now, having their altered condition in mind. We have ploughed some soils that should never have been broken; we must correct that error and prevent as far as possible its repetition."

In dealing with this it is suggested that: "The reclamation programme should provide for a thorough survey of the area affected or likely to be affected. Such a survey should include a soil survey, a topographical survey, a survey of the native vegetation, a survey of the precipitation, temperature and other climatic records, and a review of the record of agricultural production. The report should be accompanied by specific recommendations regarding agricultural production plans for each separate soil zone.

"The reclamation programme should also provide for the creation of forest or grass land reserves on any obviously inferior land areas; it should provide for tree planting for protective purposes on the open land; it should provide for the construction of dams in streams, wherever economically feasible, and it should provide for the construction of dugouts for water storage purposes on lands where stream water is not available and where well water is not obtainable or is for any reason unsuitable. It should provide for an intensive programme of education on the best methods of soil management and crop production in areas of low precipitation and where the soil is likely to drift. It should emphasize the necessity of saving the run-off water and of lessening evaporation and wind velocity."

This is a problem that needs very careful study by all scientific men—scientific agriculturists, physicists, and so on, gathering together the knowledge that is available from these sources, and that you may make an historical review of the droughts that have occurred in the past ages. Having made this study of all the facts that can be obtained, having analyzed all the information, then decide on what the plan should be and what the programme should be for the reclamation or protection of the drought area. When the plan is made it is then time to start on the work and as the work is done, each piece becomes a unit of the final completed scheme.

John Patterson[8]

From some of the remarks that have been made it would appear as if there is an idea that the proposed conservation methods will affect the climate of the province or country. It may be well to point out therefore, that the climate in any place or region is made up of the average weather conditions that prevail from day to day or even from hour to hour. The weather at any particular time and place is dependent upon the operation of world wide forces, and consequently it would be impossible to change the climate of the place by any conservation methods that might be adopted.

With regard to the creating of reservoirs and dams, etc., for the storing of waters, it would appear from the paper dealing with the mineral salts contained in the water that there might be a concentration of salt sufficient to render the stored water unfit for use. Possibly this is not a problem in the areas involved, but at the same time it is one that should be carefully examined before the reservoirs or dams are constructed.

Mr. Main in his address pointed out that there was a gradual increase of temperature in certain places in the west. This however is not only characteristic of the west, but has been noticed in eastern Canada and in many other places. It seems to be a world wide movement, and there is no doubt that in other regions the reverse is taking place. The mean temperature over the world is probably very constant and these fluctuations at different places will in the end balance out.

T. C. Main, A.M.E.I.C.[9]

The large amount of discussion of this paper is believed by the author to indicate the tremendous interest taken in this serious national problem. This is a source of satisfaction as the chief object of his paper was not the solution of a problem forthwith, but rather to stimulate interest, study and discussion so that in time a satisfactory formula might be found.

Adverse criticism in general may be summed up under two heads, i.e. (1) Denial that conservation of water and planting of trees and hedges will have any effect on climate, and (2) Belief that we cannot afford to carry out some of the larger projects suggested.

Regarding the first, it must be stated that there was no intention of suggesting that conserving water and planting trees and hedges would have any considerable effect on the general climate of the country. There is plenty of evidence, however, to show that water, trees and hedges do have a marked and beneficial effect on plant life within a comparatively narrow radius of influence and therefore must effect the microclimate with which plant life is so intimately associated. In the case of trees and hedges (and particularly the latter) this is due first to a reduction in wind velocity to a distance of approximately 20 times the height of the hedge on the lea side and 5 times the height on the windward side. With a reduction in wind velocity comes a reduction of evaporation and hence more moisture for the growing crop. In addition of course some snow is trapped during the winter and this again means more moisture and heavier yields.

In the case of water areas, vegetation is benefited by the maintenance of a higher water table thus making moisture available to plant life around the perimeter of lake or reservoir. The chief reason for impounding water of course is for the more obvious reasons given in the paper itself.

Regarding the second major criticism, i.e., the economic problem involved in the construction of some of the larger proposals, it is admitted that some of these projects cannot be justified by our present economic theories. It is perfectly evident, however, that these theories at the moment are being subjected to the most critical inspection they have ever undergone. It seems probable that the apparently static quality of the current depression primarily is due to the fact that problems are considered chiefly from the financial point of view. In the present case the fact that sufficient men-days have been wasted during the past five years to complete all the projects involved seems to be entirely ignored, and it would seem to be of primary importance.

It seems probable that eventually a system will be evolved whereby only two criteria will decide whether a given project should be constructed or not, i.e. (1) Will the proposed works be of sufficient social benefit? and (2) Is there sufficient surplus labour available to insure completion of the project? If the answer to both of these questions is in the affirmative the project will be constructed.

This philosophy appears to be the only justification for many of the larger projects under construction in the United States at the present time. Judged by our current economic theories many of these projects are shown to be unsound* and therefore should not be seriously considered. Surely it is far more unsound to have millions of able-bodied man, willing and anxious to work, on the relief rolls? It would seem that this is another national problem that might be studied by the members of our profession with benefit to our country and ourselves.

Again, the chief reason for suggesting a large number of projects was not the desire that they should be undertaken forthwith, but rather the hope of stimulating interest in water conservation in general, to the end that our water resources might be thoroughly studied and plans evolved for scientific conservation and use of our second most important natural resource.

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[7] Deputy Minister of Mines and Natural Resources, Province of Manitoba, Winnipeg, Man.

[8] Director, Meteorological Service of Canada, Toronto, Ont.

* In an address to the Canadian Club in Winnipeg, October 24th, 1934.

[9] Assistant Engineer, Water Supply, Canadian National Railways, Winnipeg, Man.

* Engineering News Record, November 29th, 1934.

F. K. Beach, A.M.E.I.C.[10]

Mr. Main has presented the results of careful study and research in his Figs. 3 and 4. It is news to many and to the writer that there has been a progressive and long time increase in mean temperature. The general agreement among numerous widely separated stations is too consistent to be attributable to local vagaries, while the consistently increasing curve rather washes out speculations as to mutual effects between temperature and evaporation.

Whether there has actually been a 20 per cent increase in evaporation concurrent with a 4-degree rise in annual mean temperature is somewhat problematic considering how closely evaporation is tied in with per cent humidity of the air and freedom of movement of air over a surface of evaporation. Some years ago the writer made a study of an irrigation reservoir, measuring all water passing in and out during the season, collecting rainfall records and carefully estimating natural inflow, and making an allowance for evaporation based on an experimental evaporation pan a few miles distant. In the course of the enquiry into evaporation data, it was found that records were being obtained in a second pan not far distant, but the records were not at all comparable. Temperatures and air humidity were quite comparable, but at the second pan a shelter belt of trees had grown up and over a period of four or five years this tree growth had most strikingly decreased the evaporation rate. Since over most of the prairie where drought has become an increasingly serious problem there has been no general increase in magnitude of windbreaks, one is inclined to put considerable weight on the progressive increase in temperature as a contributing factor in drought conditions, and this fact finding is distinctly to Mr. Main's credit.

Respecting the plotted relation between sun spot numbers and run-off, the writer is interested but doubtful as to the acceptance of any easily formulated relation applicable to the prairies in general. It might be suggested that it was merely a chance that the Red river at Emerson was selected for comparison, for if any stream rising in the Rocky Mountains and flowing eastward had been chosen, the picture would have been different. To quote only one year, 1915 was just an average run-off year in Red river, but it was a maximum year in all the mountain tributaries of the Saskatchewan river. The rainfall was heavy eastward as well, and numerous fields produced 65 bushels of wheat per acre around Swift Current, Vanguard and Gull Lake. The prairie farmer would very much like to know before seeding time whether rainfall is likely to be adequate for a crop. If there is any way of foretelling this, by all means let us have it, but it is to be feared that this is not possible. That there may be a relation for various localities between sun spot number and rainfall is just possible. In connection with both relations shown, that is, progressive temperature change and sun spots, it is of interest to note a publication by the United States Geological Survey.*

Varves are deposits of mud laid down in still water which by alternations of colour indicate spring freshets and summer inflow and thus become analogous to annual rings of tree growth. Since the thickness of each layer is proportional to run-off, they give a long time record of inflow to the lake where they were laid down. This author in studying the Green river formation of Colorado, Wyoming and Utah, found three cycles of run-off suggested. One cycle appears to have the frequency of sun spot numbers, but the interval between maxima varies from seven to seventeen years. A second cycle appears to have a frequency of about fifty years, while a third cycle corresponds with the precession of the equinoxes or about twenty-one thousand, six hundred years.

Under the heading "Utilization of Water" Mr. Main suggests "an ideal arrangement would be to provide water under pressure" at intervals of two miles, and contemplates such water in quantities sufficient to irrigate 15 to 25 acres per quarter section, as well as for other domestic purposes. That picture might well have been amplified as for the Riverhurst proposal alone this would call for steel pipe on the order of half a million tons. With this business in sight one could possibly have a steel industry in western Canada. Think of the men that would be put to work in British Columbia mining and smelting camps, in Alberta and British Columbia coal mines, in railway train service. Clothing—overalls, boots and gloves—would boost eastern Canada's factory output, and how many others would indirectly benefit.

But——who pays for all this programme? It is only when the economics of the proposal are reached that difficulties are encountered. In Alberta when wheat was worth $1.50 a bushel, it was known that the farmer could not afford to irrigate wheat. When other prices were on a par with $1.50 wheat, the irrigation farmer was hard put to it to find $100 a year for water rights on 40 acres. Can a farmer on a quarter section with 15 to 25 acres of hay watered be expected to find any more than $100 or $200 a year for water? In one irrigation scheme in Alberta where there was no extraordinary engineering structure to build up the cost, where the water is carried in earthen canals cheaply and quickly to the user, where soil conditions and climate are as favourable as can be found in the Canadian prairies, capital charges have all come from public revenue.

The psychological factor cannot be ignored. An irrigation scheme is not expected to yield a profit. Therefore its bonds will not be purchased by a person who has savings on which he wants interest with security. If the scheme is larger than a very small project, it must be financed from public credit, and once it is so financed the water users organize themselves to resist paying. Where a bank or mortgage company would evict and put in a new tenant, the water users make a political issue of all efforts to collect. With this general premise, it is therefore suggested that before recommending so large a scheme as the Riverhurst proposal, or the William Pearce project, it should be suggested to the sponsors that they must expect to supply all the capital cost without hope of repayment, that they be prepared to maintain and operate the scheme in perpetuity without ever recovering more than a fraction of the cost of operation, and in all probability they may be called on to subsidize crops raised by the water supplied.

The writer feels that it is hardly fair to ask the farmer in humid parts of Canada to subsidize the drought areas to compete with him, and if the farmer in humid areas is not to contribute, many other classes dependent on him must be exempt. If it was certain that by constructing vast water supply systems lasting prosperity might be brought to the whole of Canada, a demand could be made that the farmer of humid districts and those dependent on him waive their objections to such subsidizing of the drought areas. Major Duncan Stuart, K.C., of Calgary, in a recent pamphlet*, shows that Persepolis was built in a steppe resembling our Canadian prairie, and that pulverization of the soil from farming operations coupled with a rainfall that could not be depended on, ended in shifting dunes and total desert. If the financial support of the Ontario farmer is demanded to pipe water widely over drought areas, or to lead it in canals, and then it is found that soil drifting has merely been invited, have engineers been true to their creed?

If wholesale reclamation is condemned, what can be recommended? The answer is not simple. No one answer can be given offhand. It does seem certain, however, that the desert or semi-desert of our drought areas must call for a culture of living as well as a culture of land which differs from the habits of humid areas. The wheat farmer expected to work sixty days in the year. That is out. Much of the drought area must go back to grass and grazing. Small reservoirs easily constructed from simple labour can be developed. In Alberta considerable progress is already under way along both these lines. Control of water well drilling and a kindly, scientific guidance in the individual efforts of the inhabitants who choose to remain, will help to develop ground water supplies where they are available, and prevent to some extent any over exploitation of this valuable resource, or its contamination or dissipation from bad drilling practices. Permanent retention of geological personnel and co-ordinated records of water wells would not be costly and Mr. W. Calder has made a suggestion along this line.

To summarize, the mean annual temperature has been increasing over a cycle greater than the cycle of sun spot numbers. Possibly it is on the turn and may be a 50-year cycle that will in a few years decrease natural evaporation to a point where crops can again be raised, but this is not definitely known as yet. Wholesale reclamation is bad from a psychological standpoint, and probably bad from a soil drifting standpoint. Small reservoirs to delay run-off and thus encourage retention of moisture in the air can properly be sponsored but they should be done by local effort. Well drilling should be supervised and guided by geological advice and records. Much of the drought area must go back to grazing, and those who remain on the land must adopt a culture suited to the climate in which they live. Those who demand a higher standard of living than the climate will support should go to a climate that will support the standards they set for themselves.

F. W. Caldwell, M.E.I.C.[11]

Premier Bracken's views as described to the meeting must command attention of all members of The Institute and economists and physicists. Here is a great opportunity for engineering activities in planning for the future of the prairie provinces. To set out all their natural resources is to plan for all Canada. Now in the United States there are forty-one State Planning Boards, besides two Regional Planning Boards, one of the latter being the Mississippi Valley Committee. Preliminary plans for a state may cost from $50,000 to $75,000 at the present time. This small amount of money will be made up by the saving of a few farms from bankruptcy or even be disposed of in the water supply of only one small town. These boards plan for the economic whole of a province or district and not only for water or weather. The entire natural resources are considered.

In the report of the Mississippi Valley Committee of the Public Works Administration, information is found as to the lowering of ground water from 10 to 20 feet in North and South Dakota and special comments on artesian well laws. Areas of the Hudson Bay basin below the international boundary are shown in social and economic status as well as in water supply classification. This report states the Red

[10] Petroleum Engineer, Petroleum and Natural Gas Division, Department of the Interior, Edmonton, Alta.

* "Varves and Climate of the Green River Epoch" by Wilmot H. Bradley (Professional Paper 158E, 1929).

* "The Canadian Desert."

[11] New York State Planning Board, Albany, N.Y.

river of the north valley is from 30 to 50 miles wide on either side of the river (referring of course to the portion in the United States). The valley is a flat surface of alluvial soil left in the basin of geological lake Agassiz. The mean annual precipitation is 20 inches. A land use plan must consider this valley subject to the humidity of the east and the aridity of the west. The problem is to adjust the most favourable relation of factors included in this climatic area.

The Red river receives waste from Wahpeton, Fargo, Morehead, Grand Forks and lesser cities. At Grand Forks, with a drainage area of 25,000 square miles, it reaches a volume of 43,000 cubic feet per second or about one tenth the flood flow of that of our eastern streams with the same watershed area, but in October 1932, the flow was only 13 cubic feet per second and it became an open sewer. In the winter it freezes to the bottom. A careful balance between uses of surface water, underground water, and drainage must be maintained. This river is, of course, in the eastern edge of the dry climate section, but it is also important on account of having such large portions of its basin both above and below the boundary line between the two countries.

The assembling of maps of the entire arid area, all drawn to one scale so they can be readily superimposed for study, would be a progressive step. In Mr. Main's paper are two maps and in Messrs. Perry and Johnson's one each. It is to be hoped that more information can be collected and presented at future meetings of The Institute on this important subject, which is really basic to the planning of a very large portion of Canada's future.

E. F. Chandler[12]

An enthusiastic desire to endorse almost every statement in the paper by Mr. P. C. Perry is aroused in the study of it by anyone who, like the writer, has had for thirty-two years detailed continuous knowledge of the behaviour of all the typical surface streams in the region adjoining on the southeast, the entire state of North Dakota and considerable surrounding area. In this district many of the rivers have conditions similar to the district described in Manitoba, Saskatchewan and Alberta; and one river station in particular, maintained for more than thirty years at Minot, North Dakota, is on one of the streams listed, the Souris river, where it loops south into North Dakota.

If there is no difference in opinion from the statements made by the author, perhaps it is superflous to discuss them. But mention may be made of the excellent agreements in our figures. In North Dakota, a prairie region where the average annual precipitation is about 20 inches at the eastern end and 15 inches at the western end, the long extended records have shown for all the streams rising within the state average annual run-off of less than one inch, and for those most closely resembling such Canadian streams as the Souris an annual run-off from a quarter inch to a half inch.

For the ordinary gross evaporation to be expected from average lake or reservoir surface, the writer's own figures are 33 inches for each twelve-month period. For evaporation and vegetal-transpiration from land surface in this region, 20 inches per year if as much as that is supplied by precipitation and is thus available giving "evaporation opportunity."

In this region run-off cannot logically be considered as a percentage or fraction of the annual precipitation; although its amount is so small as in most years to be only between one and five per cent of the rainfall; but it is really not a fraction but a remainder, after evaporation has taken away 20 inches or thereabouts if there was opportunity.

As rainfall is usually less than 20 inches, the run-off is merely such accidental portion of precipitation as runs off quickly from sudden storms before it can be clutched by the dry soil or taken by evaporation, or as flow off in spring when deep wet snowdrifts melt quickly or when the soil spaces are largely sealed by frost, or under other special temporary conditions. This run-off is usually merely a very small portion of the local precipitation, likely to be almost inappreciable except in early spring. On such streams in many of the years more than half of the total annual run-off passes within two or three weeks of the spring.

The total amount depends therefore so much on accidental local temporary conditions that it is difficult here to set definite figures in prediction of floods more than a few days in advance. Most predictions are merely rough guesses.

The variation between different years is very great. For example, on the Souris river at Minot the total flow of the worst flood year recorded, 1904, was about a hundred times as much as the total flow for the twelve months of 1915, although 1915 was not a so-called drought year; it was merely a year in which the total rainfall was slightly deficient because it included no heavy cloudbursts, but was composed of well-separated gentle rains giving a reasonably good supply for agriculture. And in some of the recent years of extreme drought the run-off has been still smaller.

Nevertheless there is some flow every year, and in occasional years a large flood. Hence such storage projects as recommended by the author are very desirable. The reservoir storage may be a ridiculously small fraction of the total annual precipitation, but it can easily be a very considerable portion of the total run-off even of a "flood year." Besides lessening to some slight extent the danger of flood-injuries along the valleys below, such reservoirs hold for the general benefit of the region a part of the run-off from one month to the next or one year to the next, into the dry seasons, providing a permanent supply that is in many ways very advantageous. One of these benefits that at first thought often escapes attention is the ease with which trees can be grown near such reservoirs, totalling a very considerable acreage which may add greatly to the comfort or enjoyment of life for all in the neighbourhood.

The benefits of such reservoirs, smaller or larger, in the prairie regions are so many that their construction ought to be encouraged wherever feasible.

J. W. D. Farrell, A.M.E.I.C.[13]

Mr. Main's excellent paper should have a tonic effect on the most discouraged dweller of the southern prairies, and also put fresh energy into those vigorous persons who are determined to find ways of making the next drought less devastating. If the indicated improvements in climatic conditions materialize, it is to be hoped that the almost certain prospect of a return of drought conditions in ten to twenty years will not be overlooked. If an incentive to prepare against drought is needed, the author provides it in pointing out that remedial measures are also those needed to bring ordinary living conditions in rural communities up to a more tenable standard.

The author's data showing that climatic conditions productive of drought occur in recognizable though irregular periods are a valuable feature of the paper. In looking at drought conditions of the past few years, it must not be overlooked that the climatic records show that periods of three or four years of low precipitation are separated by much longer periods of sufficient moisture. That is, drought is the exception and there are now several years in which to adopt measures which should greatly moderate the effect of the next drought. It should be particularly noted that Mr. Main does not claim that remedial measures will change the climate but will moderate its effect. A personal recollection of previous periods of low precipitation shows that some of the worst features of the recent drought, such as soil drifting, were absent. Recovery was also more rapid. The waste of surface water combined with heavy cropping have undoubtedly made the recent drought far more serious and prolonged than previous droughts.

In attempting to discuss some features of the paper, one is almost irresistibly drawn to the economic side of the question and not without reason. In the area affected there is a capital investment of millions of dollars represented by railways, elevators, highways, telephone systems and all the buildings and appurtenances of the cities, towns, villages and farms. In the past, this area has produced a great deal of wealth. On the human side there are thousands of people living in the area. The economic and humanitarian reasons for adopting suitable measures of rehabilitation are more than sufficient. An important item in any such measure is certainly the conservation of water resources.

World economic conditions should assist the plan for water conservation. A limitation in our exportation and therefore in our production of wheat is a recognized situation. Reduced production means less acreage so that the land needed for water storage can be readily yielded. With more water available more livestock may be kept and land needed for pasture and fodder crop would further reduce the wheat acreage, and the area subject to soil drifting. If the area under consideration is due for a shrinkage both in population and production, it will surely be better that readjustment take place along organized lines, retaining the occupants of lands that can be reached by the proposed improvements and assisting others to move.

Those paragraphs of Mr. Main's paper under the heading "Economics of Rehabilitation" should be particularly arresting to the attention of taxpayers and governing bodies, alike. If the present financial system is not capable of providing the necessary funds to float useful work projects to completion, then there is need for reform. Money and credit should be recognized as a utility and administered as a government monopoly.

Turning to the engineering features of the paper, it is interesting to note that irrigation is not intended in the usual sense of the word. Instead of supplying water to field crops in a large way during the growing season, the term as Mr. Main uses it, indicates the provision of limited quantities of water for some crops and the year round provision of water for human and animal consumption. In a country that can already produce more wheat than it can sell, there would be no justification in an irrigation scheme for producing still more wheat.

In considering water conservation by the means suggested, mostly by surface storage, one must beware of expecting too much. In regulating spring flood conditions on a recognized water course, much

[12] Professor of Civil Engineering (and Dean-emeritus College of Engineering), University of North Dakota, University Station, Grand Forks, N.D.

[13] Superintendent of Waterworks, City of Regina, Sask.

tact and care would be needed to avoid depriving the lower part of a water course of what might be considered its rightful supply. The spring flooding of a hay flat, wasteful though it may be, could not be replaced by the gradual flow confined to the stream bed during the summer.

Many of the proposed reservoirs would not survive a prolonged and severe drought such as that of 1928 to 1931 but they would do much to better conditions between droughts and would likely survive short droughts and shorten their effect. For these reasons and for the improvement to living conditions between droughts, they would be well worth while.

As an example, Wascana Lake is an artificial lake, mostly in the city of Regina; it has an area of some 200 acres and is supplied by the run-off from quite a large watershed. In June of 1928 rain was very plentiful and the lake was full. In 1931 it was necessary to conserve all the inflow in the upper third of the lake for the benefit of the city power house, and by the fall of 1931, the lower two-thirds of the lake was so nearly empty that the remaining water was run out and the bottom of the lake was cleaned and deepened. In 1932, although precipitation was above the average, the lake was only partly filled and it was not until the spring of 1934 that the lake was again full to the spillway. During 1929 and 1930, some water was used from the lake for sprinkling the adjoining parks but none was available for running down stream. If there had been any irrigation scheme dependent on this lake, water taken for its purposes would have hastened the day of the lake being empty. During the minor drought of 1917, 1918, and 1919, Wascana Lake did not go dry. The experience of Wascana Lake during 1928 to 1931 was duplicated to a less degree at the Canadian National Railways reservoir near Condie.

John C. Hoyt[14]

The paper by Mr. L. A. Jones on water phases of our drought relief programme indicates concisely conditions in the United States. The indications are that as droughts are liable to occur at frequent intervals, damages from them can be arrested only by adjusting development, both as to extent and character to available water supplies. This will require more detailed studies of available supplies and of the possibilities for their conservation and use. As the disastrous effects of droughts, in the main, relate to agriculture, the problem will require special studies as to the fitness of land areas to various types of agriculture. In fact, it is largely a land use problem.

D. A. R. McCannel, m.e.i.c.[15]

The extent of precipitation is not as important as the time of year during which it occurs, in so far as its effect upon cereal crops is concerned. Cereal crops have in the past, and will continue in the future, to be the main crop for the prairie provinces. Frequent moderate rainfall during the growing season—June and July—will provide for the production of a normal crop and the benefit of such conditions were borne out by the bumper crop of 1916. The increasing daily mean temperature, referred to by Mr. Main, may not seriously effect the evaporation of useful moisture for cereal crops provided the rise in temperatures are experienced during the winter months, and such is largely the case. Under such a condition, the increased rate of evaporation of 21.6 per cent may not seriously affect the crop yield.

Concerning the use of water—in the past the tendency in farming has been towards larger holdings, and with cereal crops remaining the major product, this tendency will continue assisting the farmer to combat low prices, by reducing his overhead and cost of production. Such a tendency would not appear to demand an increase in the use of water by the rural areas.

Irrigation will result in intensive farming and would appear to be limited to restricted areas where the cost must be comparatively low. The utilization of water delivered through pipes appears to be prohibited from a cost standpoint. With the excessive low temperatures demanding expensive construction to overcome liability for frost and the high cost of long life pipe, the use of water delivered through pipes would be on a very restricted scale.

Mr. Main has outlined the economics of rehabilitation and to utilize this potential power to the full, the writer would suggest the first step be towards conservation of water by the construction of a large number of small works or dams, which should be located close to the potential power available, and would be of immediate and direct benefit to those adjacent to their construction. Engineering advice on their location and construction should be sought and provided. Such local works could be scattered throughout the drought area and could be undertaken with a minimum of time for preliminary work. The large projects suggested for consideration have received some study, but many of them are of such magnitude as to demand considerable further detailed study of their possibilities and costs before they should be undertaken. Those that are found to be advantageous will demand time and expense for investigation and acquiring of property, and the time required to get them under way might prevent the possibility of utilizing the potential power now available. Works providing the greatest good to the greatest number should be a primary consideration, and small projects which include dams and reservoirs, including dug-outs, should be the first undertaking, and would utilize this potential power to the best advantage.

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[15] City Engineer, City of Regina, Sask.

C. J. McGavin, a.m.e.i.c.[16]

There appears to be a great tendency on the part of recent investigators to prove from the established eleven-and-a-quarter-year cycle (sun spot data) the effectiveness of this cycle in relation to terrestrial phenomena.

The writer made a study of comparison of run-off and precipitation records for seven stations, viz.: Winnipeg and Brandon in Manitoba; Qu'Appelle and Battleford, Saskatchewan; Medicine Hat, Edmonton and Calgary, Alberta; for the thirty-year period 1891 to 1920, with the Winnipeg records dating back to 1872. Normals were arrived at and the percentage of precipitation for each based on normals was analyzed with the following result.

Only during the four years 1898, 1901, 1911 and 1916 did the records show increased precipitation over the normal at all seven stations. Only during the five years 1892, 1894, 1910, 1917 and 1918 did the records show precipitation at all stations below the normal.

By applying all the experience gained from the practice of jig-saw puzzles and with the defined purpose of making "The Punishment Fit the Crime" it was impossible to prove the relationship of our precipitation records to the cycle.

The study suggests, however, cycles of wet and dry years, which do not correspond for different parts of the three provinces, local variations occuring at comparatively short distances with no exact ratio between the precipitation at one point and the run-off conditions.

It was further found that forecasting on the basis of the data obtained shows:

That three years as dry as 1919 may be expected in a period of thirty-nine years, i.e., one year in thirteen.

That five years as wet as 1916 may be expected in thirty-nine years, i.e., one year in 7.8.

According to Dr. W. S. Adams, Director of Mount Wilson Observatory, there is evidence of a correlation between cycles and atmospheric temperatures, but further than that he is reluctant to go. An examination of records appears to show lag and distortion. The warm years of 1921 and 1922 show synchronizing with the 1923 sun spot "low."

Mr. Main has apparently found correlation with the eleven-year cycle and stream flow on a Manitoba stream.

In considering the years of maxima sun spot data shown on Mr. Main's report, 1883, 1893, 1905, 1917, 1928, 1938, it is found that, while they are no doubt conscientiously chosen, even the sun spot data has a tendency towards elasticity with different investigators. J. W. Shuman, Minneapolis, chose the years 1861, 1871, 1882, 1893, 1906, 1918 and only in the year 1893 does the maximum harmonize with Mr. Main's.

The writer found that, where the Red river, studied by Mr. Main, showed a steady decrease in discharge from 1927 to 1933, the Churchill river records show a decided yearly increase during the same period. It would therefore appear advisable as suggested by Mr. Main to give further study to the subject before accepting his interesting results.

In order to secure consistency in estimate of run-off the period 1911 to 1920 inclusive was chosen tentatively as a standard decade. The assumption that the period will give a true normal is based on a comparison of long term precipitation records as follows:

	Calgary	Medicine Hat
Normal annual precipitation for period of 30 years..................(Inches)	15.84	12.91
Mean annual precipitation for decade 1911 to 1920 inclusive...........(Inches)	15.44	12.71
Percentage..........................	97.5	98.5

Verification was also made with long term precipitation records at Edmonton, Qu'Appelle, Grenfell and Swift Current. The general average for Alberta and Saskatchewan, respectively, shows that the decade is practically the same as that for the long term periods.

The adoption of the period has given generally satisfactory results, but hydrometric records show that a term of fifty to sixty years is necessary in connection with expected flood discharge for the design of large expensive structures. Until further records are obtained it will be necessary to assume certain relations between the maxima for ten, fifteen and thirty years respectively based on a comparison of available data.

Stream records when supplemented by the use of lake levels and precipitation indicate that the areas of very high and very low run-off in any one year are probably smaller than might be assumed from the stream records alone. There is therefore, a limit to the safe use of the ordinary methods of correlation, as direct stream records only cover a relatively small portion of the provinces.

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Studies in connection with maximum run-off show that stream records do not indicate the potential maxima or even a constant proportion of such maxima. The maximum rate per square mile of drainage area varies considerably according to size and shape of the drainage basin, as referred to later, so that true or consistent coefficients cannot be obtained by merely dividing the flow by the discharge area.

Streams even in flat country are likely to experience unprecedentedly high potential maxima. Some progress is being made by the writer in preparing maps showing the run-off for the areas in the different drainage basins.

Davis creek draining south-east from the Cypress Hills shows the heaviest run-off south of the bush country being 165 acre-feet to the square mile and Eyehill creek near Yonker the lowest with 2 acre-feet per square mile.

In estimating losses from lakes and reservoirs in the prairie provinces where it is necessary to use fairly close estimates of evaporation it is found that with the relatively few summer records the normal depth of evaporation in inches per year corresponds approximately to the mean temperature over a number of years. As a result the method of estimating the mean temperature by altitude and location when actual records are inadequate gives fairly satisfactory results.

Local variations of temperature being chiefly due to altitude may be estimated on the basis of one degree decrease for every 300 feet of altitude,* but there is a further loss of about one degree temperature for every degree of latitude, and in Alberta and Saskatchewan a gain of about one-half a degree in temperature for every degree of longitude. The latter correction is due to the relative distance from the Pacific Ocean. These conclusions suggest a convenient means of estimating temperature embracing altitude and location by the following formula:—

$$T = C + M - 2L - \frac{A}{300}$$

where T = Mean temperature
C = A coefficient of about 38 (Manitoba 39)
M = Meridian
L = Latitude
A = Altitude in feet.

The value of "C" is derived from thirty years records as follows:

Stations	Mean Temp. for 30 yrs.	Correction for location $114°_M\ 50°_L$	Correction for sea level	"C"	Per cent for 38
Calgary	37.80	−11.97	+11.43	37.26	−2
Medicine Hat	41.70	−10.35	+ 7.06	38.41	+1
Edmonton	36.90	− 6.40	+ 7.02	37.52	−1
				37.73	−0.6
Swift Current	38.10	− 7.08	+ 7.97	38.99	+2.5
Qu'Appelle	34.50	− 2.78	+ 7.05	38.77	+2.0
Prince Albert	31.70	+ 0.70	+ 4.83	37.23	−2.3
				38.33	+1
Minnedosa	33.80	+ 0.67	+ 5.63	40.10	+5.5
St. Albans	35.40	− 0.18	+ 3.93	39.15	+3
Hillview	33.20	− 0.63	+ 4.67	37.24	−2
				38.83	+2.0

It is often necessary to estimate monthly evaporation where only temperature records are available and it is found that if we assume other conditions to be equal the approximate relation of evaporation to temperature is as follows: $\text{Log } E = \frac{T - C}{62}$

where E = Evaporation in water for one month
T = Mean temperature
C = Coefficient depending on relative humidity, etc., and other local factors.

Actual records naturally vary from this equation which was based on average or records extending up to eleven years at several stations. For mass curve estimates they afford a ready means of applying the available data to normal conditions in other respects than temperature. The formula further provides a standard by which to compare data affected by unusual wind and other conditions.

Practically no records of winter evaporation are available and this formula can be used with the average value of "C" denominator (62) for completing partial records to include winter evaporation from monthly records of temperature.

* Meyers "Hydrology," p. 23.

The formula gives the following comparative figures:—

Temperature Degrees Fah.	Evaporation Inches
−20	0.31
−10	0.45
0	0.65
+10	0.93
+20	1.35
+30	1.95
+40	2.85
+50	4.10
+60	6.10
+70	8.50

While temperature is a very important factor in the study of evaporation, equally important is the effect of wind action, removing as it does the protective vapour blanket from above the water surface. The rate of evaporation is caused by wind and in the southern part of our provinces the evaporation opportunity, through the effect of wind, is high.

As one interested in conservation and its attendant factors for many years, and with the experience of administering "Water Rights" in the province of Saskatchewan for the past four years, the writer feels that our most urgent need is the construction, under supervision, of domestic and stock-watering dams together with a plan which would, by contact, assist the farmer in fostering existing irrigation schemes (44,000 acres). It might be also possible to locate and develop small projects that prove on examination to be economically feasible.

Mr. Main in his report proposes the investigation of several large projects many of which will no doubt prove to have merit, particularly from the standpoint of regulating low flow and increasing ground water supply by percolation.

It is suggested that if money becomes available an inventory be made of the possible supply, from wells, creeks, lakes and other sources in each township throughout the drought area. The requirements for a township, accepting the average farm in the grain growing district as one half section, and allowing for losses, are 60 acre-feet per annum.

The quantity required is not large and the cost of construction for low dams would not be great. Where no natural creek beds or depressions are found dugouts might be constructed on suitable sites 200 by 60 by 12 feet. With four to a township a supply of 2,203,368 gallons could be made available after allowing for losses. The quantity would provide a supply for seventy-three days, without considering wells.

It would be of particular interest to this province to have a continuance of the excellent work performed in the Carnduff district by Kirk and Wickenden extended over other areas, should money be made available for such purpose.

While the writer is in agreement with Mr. Perry that our stream flow is primarily dependent upon fall and winter precipitation, it is felt that in compiling his curves as from October 1st to September 30th thus eliminating the month of September as not being dependent he is not in accordance with views now to be set forth.

A study of soil moisture shows that there are two opposing forces, gravity and capillarity—one downward and the other upward. Any added water applied at the surface will unbalance equilibrium and release water to the ground water table. The capillary water assists in controlling the downward movement of additional water as it fills the minute channels, and it acts as a buffer when increased flows are applied.

In September our early frosts stop most plant transpiration. Any precipitation has a chance of filling the capillary pores and has little chance of being affected later by evaporation as October is generally cool, and while there are snows in October they usually evaporate. September on the basis of the above would appear to be the important month for ground water storage.

Spring floods are related to annual temperature, and winter temperature curves closely parallel the annual because they make up a large part of it. The main factors for spring floods are available moisture (usually in March), late springs, with intermittent thaws, sudden and warm weather or hot rains, and a soil previously filled with moisture from fall rains.

There appears to be enough water in a normal winter's snowfall to make a flood if other factors are favourable.

The last floods at Minot, North Dakota, occurred when the average was less than normal. In fact according to figures given by R. E. Kennedy, state engineer, North Dakota, the lowest point on the curve of 2.4 inches.

So, for watersheds not subject to summer floods, the annual temperature has a definite connection with the flood occurrence.

Concerning deforestation, Mr. J. C. Stevens, Portland, Oregon says:

"After many years of guessing and useless argument some authentic information has been produced at last as to the effect of forests on stream flow. The final conclusions are exceedingly simple. They might have been—in fact, actually were—anticipated many years ago. The forest, like every other vegetable crop, consumes large quantities of water for its growth. Unlike some plants, however, it also dissipates large quantities of water by mechanical means. It prevents a substantial portion of rain and snow from reaching the soil, permitting rapid evaporation from branches and leaves. When the forest is removed the water thus consumed by it appears as run-off. As new growths appear the run-off gradually diminishes again in proportion to this crop and mechanical consumption."

Professor D. W. Mead, University of Wisconsin, quotes from experiments made in Wisconsin in 1929:

"The highest average percentage of run-off found was less than 2 per cent for forest covering, 20.1 per cent for pastures, 24.1 per cent for oat lands, 25.6 per cent for corn lands, and 21.5 per cent for hay lands, the last three being probably somewhat reduced by the less average slopes."

The inference is "that sod yields less run-off, consumes more water and returns more to the atmosphere than certain cultivated crops do."

Professor Mead says referring to Devil's Lake: "Since the land around the lake has been settled and cultivated there has been a considerable decrease in run-off and a marked shrinkage in the height and area of the lake, evidently due to the opening of the lands by cultivation."

A paper prepared by Raphael Zon, Director, Lake States Forest Experiment Station, is of particular interest, bringing together impartially all the well-established scientific facts in regard to the relation of forests to water supply and his summing up is as follows:

1. The total discharge of large rivers depends upon climate, precipitation and evaporation. The observed fluctuation in the total amount of water carried by rivers during a long period of years depends upon climatic cycles of wet and dry years.

2. The regularity of flow of rivers and streams throughout the year depends upon the storage capacity of the watershed, which feeds the stored water to the streams during the summer through underground seepage and by springs. In winter the rivers are fed directly by precipitation, which reaches them chiefly as surface run-off.

3. Among the factors, such as climate and character of the soil, which affect the storage capacity of a watershed, and therefore the regularity of stream flow, the forest plays an important part, especially on impermeable soils. The mean low stages as well as the moderately high stages in the rivers depend upon the extent of forest cover on the watersheds. The forest tends to equalize the flow throughout the year by making the low stages higher and the high stages lower.

4. Floods which are produced by exceptional meteorological conditions cannot be prevented by forests, but without their mitigating influence the floods are more severe and destructive.

While Professor Chandler states that Devil's Lake has fallen 22 feet in the past fifty years, R. E. Kennedy is of the opinion that the lake has several times been dry or nearly so. Stump Lake, 25 miles from Devil's Lake, was so named according to Mr. Kennedy because uprooted, fire marked, waterlogged oak trees are slowly emerging in certain places around the shore as the water recedes. These trees are not petrified and one examined showed one hundred and sixteen rings about 12 inches in diameter, and he concludes the ground was dry for at least one hundred and sixteen years. It would appear that wet cycles have come and gone.

With respect to Johnston Lake referred to by Mr. Perry, the writer found that by getting a check-up on this lake in August and allowing for subsequent evaporation the lake has receded about 10 feet since 1883.

While it is agreed that the size of a drainage basin is a factor with precipitation in estimating run-off (with topography) the shape is also considered as being a most important factor. When one examines Moose Jaw Creek Drainage Basin it is found to be about 23 miles wide and 60 miles in length, short and narrow and similar in shape to Swift Current Creek Drainage Basin which is about 16 miles wide. Both being narrow, flood waters reach the point of discharge quickly. The area drained in both cases is partly from hills, whereas the Qu'Appelle basin is about 100 miles wide and the Souris approximately 108 miles. If one considers the length of the radiating lines from the boundaries of the drainage basin to the point of discharge it is thought that the losses would be proportionately greater and the flood stage proportionately less.

Again with the higher stage recorded at Minot with its 10,270 square miles as against Wawanesa with 23,121 square miles, an examination of the basin shows that the flood waters reaching Minot will have time to flatten out before reaching Wawanesa. Meantime the larger part of the 23,121 miles being tributary to Wawanesa will have had every opportunity of passing Wawanesa before the Minot peak reaches there.

Considering the shape of the Wawanesa basin the waters will have to come from a distance of approximately 108 miles north and 100 miles east and one would expect that the long basin, releasing all the way along will give time for the waters to get away with less chance of a peak occurring and before the Minot waters reach there.

With Swan river showing only a difference of 1.5 inches in rainfall over Swift Current creek, Mr. Perry finds the relation of run-off to be:

Swift Current....................	0.918 inches
Swan river......................	3.97 "

As temperature and winds are the principal causes of evaporation one would expect less run-off from the Swift Current district. The temperature of the air and water in the Swan river drainage basin is found to be less. Similar data on file on the two above-mentioned streams shows the run-off in second-feet per square mile to be:

Swift Current..................	5.43
Swan river......................	6.96 for the period.

Many formulae have been used for ascertaining methods of obtaining flood coefficients, a few of the better known exponents being Dickens, Walker, Ryves, Fanning, Meyers and Lillie. It is found however, that the Lillie formula* gives the most satisfactory result for the provinces under consideration.

Mr. Lillie finds that the potential maximum flood cross-section varies as a coefficient multiplied by λ for size and $\Sigma\theta L$ for shape.

In considering maximum discharges in western Canada it was found by the late Mr. Spreckley, Dominion Government Service, Calgary, that λ varies as the fourth root of the area in square miles, and $\Sigma\theta L$ is the sum of the radial distances in miles from the gauging station to the boundary of the watershed at intervals of 1 degree. It is, therefore, possible to reduce any maximum discharge to a common basis of c.f.s. per square mile as if the drainage area were 100 square miles of standard shape thus:—

If C = coefficient for 100 square miles of a shape giving $\Sigma\theta L$ = 1,000. A = drainage area, and P = maximum discharge.

Then $$P = 100\,C\left(\frac{A}{100}\right)^{\frac{1}{4}} \times \frac{\Sigma\theta L}{1000}$$

Therefore $$C = \frac{10\,P}{\frac{\sqrt[4]{A}}{100} \times \Sigma\theta L}$$

and the flood divisor used instead of the actual drainage area will be

$$\frac{\frac{\sqrt[4]{A}}{100} \times \Sigma\theta L}{10} \text{ or } \frac{\lambda\,\Sigma\theta L}{10}$$

In estimating $\Sigma\theta L$ a tracing of radial lines at intervals of 10 degrees is used.

In extending the records for short periods a straight line curve from percentages of "median" yearly maximum discharge is used and the percentages are read off on the line corresponding to the maximum (fifteen years).

C. J. Mackenzie, m.e.i.c.[17]

When Mr. Main states that "man . . . must take action to create conditions that will minimize the effects of another serious drought period when it comes, as it surely will," he expresses the "drought" problem as it appears at the moment to westerners. That the problem is one of more than local significance is realized when it is noted that in six years, 1922 to 1928, the "drought stricken" area of Saskatchewan alone produced new wealth greater than the present total indebtedness of every kind in the entire province. The question of the moment is "what conditions must we create?" Generally speaking, during the past few years there have been in western Canada two schools of thought as to what can be done. One school suggests that climatic conditions can be affected to some degree by man's efforts; that planting trees and hedges, creating large reservoirs and lakes will increase precipitation; that large scale projects, covering extensive areas, for carrying water to the treeless prairies, are desirable and practicable measures. The other school, which has the support of scientific agriculturists, in Saskatchewan at least, believes that there is no possibility of doing anything to affect measurably the rainfall or climate on the prairies; that it is quite impracticable to grow trees in extensive belts in a semi-arid, short grass country where even hard wheat, which is a semi-arid form of growth, can not survive in periods of deficiency of rainfall; that large scheme irrigation or water projects, while perhaps possible from an engineering standpoint, are not feasible from an economical point of view. The remedy, claim adherents of this school, lies rather in the field of cultural and tillage methods for the purpose of reducing evaporation on cultivated lands to a minimum, and lessening soil drifting, and on an intelligent reorganization of our social and political institutions so that all lands would be used only for purposes indicated by the soil and climatic conditions in each particular area. It has been suggested that farming operations must be planned in future on the basis of the inexorable natural laws of variation, which indicate that here, as in any country of semi-arid nature, the wide and quite natural variations in rainfall will bring again periods of drought as have occurred during the past three to five years and which, evidence

* "Discharge from Catchment Areas," Vol. 217 of the Proc. Inst. C.E. September 1924.

[17] Dean of Engineering, University of Saskatchewan, Saskatoon, Sask.

indicates, have occurred in equally severe form in past years before the country was settled. The writer feels that the latter view is the sounder, and the envisaging of a general scheme which would provide at all times an actual storage of seed grain and feed supplies in every section of the country sufficient to meet the requirements of say two drought years with perhaps an actual monetary reserve in the form of an insurance scheme for relief purposes is certainly quite as practical and probably more so than the schemes now in use and under consideration for National Unemployment Insurance. Moreover, such a scheme would involve no large initial expenditures and could be initiated very quickly.

Mr. Perry gives a sound picture of the controlling factors and character of run-off from streams draining prairie watersheds and his conclusion that only about 0.3 inches of rainfall runs off per year is significant, as it can be seen that if all of this were conserved, which of course would be impossible, and applied to the areas from which it comes, the addition would mean little in a country where the rainfall is even as limited as in Saskatchewan. The writer does not suggest that many small storage dams would not serve local farms or even small communities as suggested, and feels that, just as the railways have so successfully developed many water supplies, this effort is one that should be encouraged, but as has been indicated they must be relatively local in nature and cannot be considered as a broad national scheme for the rehabilitation of the treeless prairies considered as a whole.

The major scheme suggested by Mr. Main is of sufficient size to qualify as a broad national scheme, covering as it does an area of about five to six million acres. The water in this case is to be drawn from the South Saskatchewan river, a source uninfluenced by run-off from the prairies, but dependent on the melting snow from the mountains. The scheme of delivering water to individual farms by pipes laid along alternate road allowances, as suggested, is a bold conception, but one who has had experience with waterworks systems for small towns knows that a community of one thousand people living within the area of a village or town, with a supply at hand, can scarcely bear the overhead expense of such a system, and consequently must feel that under present economic and political conditions, when it is found to be economically impracticable to supply individual farms scattered over a large area even with electric light and power, there is not much possibility of having any such scheme in effect in time to meet the next drought. Moreover, while 6,000,000 acres is an area of some magnitude, it is a relatively small proportion of the Saskatchewan grain growing acreage, most of which is liable to years of crop failure. It is true that while in the tree belt of the north, generally speaking, the precipitation is not greater than in the south, the lower temperature and freedom from hot winds with consequent decreased evaporation make conditions quite different from those in the south, and while drought conditions are not so much to be feared, there is always the possibility of a succession of years of late spring or early fall frosts, which would mean a crop loss. There are, however, large areas between the northern limits of the present drought area and extending well into the park belt which are liable to periods of deficient rainfall and drought conditions, and to cover all this latter area, so exposed, with a waterworks system would be an undertaking of gigantic proportions to say the least.

On the other hand, a system of planning and insurance as suggested above, would cover all areas against both drought and frost, and as in all forms of insurance the greater the area covered and the numbers involved, the cheaper and safer it would be. Naturally such insurance rates would vary with the risk in different localities, but most insurance schemes are so adjusted to varying risks.

One agrees with Mr. Main that there is urgent need of a commission of enquiry of a broad nature, to bring together the expert and studied opinions of meteorologists, agriculturists, engineers and statesmen, so that all the scientific and other available information may be pooled and a plan evolved that will be authoritative and acceptable. It should be stated that several interested governments have already taken steps in this direction.

R. W. McKinnon, A.M.E.I.C.[18]

Drought conditions, in the areas now affected, are not new conditions although attended by a great deal more hardship and suffering than was experienced on previous occasions due to increased population and greater cultivation than in past years which has drawn heavily on the ground water supply during periods of low precipitation.

In this semi-arid area, the success or failure of a crop is as dependent on the time of precipitation and the condition of the soil to take advantage of such precipitation, as it is upon its amount. This condition applies to the prairie provinces as a whole and is not particularly confined to the drought area.

The study of conditions throughout Manitoba has led the writer to the conclusion that the year following a comparatively wet fall with early frost and late snow is one in which without early normal summer precipitation, crop conditions are poor. Frozen condition of the earth in the early spring makes it impossible for the soil to take advantage of or store-up the early spring run-off. On the other hand, a dry fall with early frosts and late snow or early snows and late frosts enable the soil to take full advantage of the spring run-off. In the case of the comparatively dry fall and early frosts, large cracks form inlets through which the water is absorbed. In the case of early snows and late frosts, absorption takes place with little movement of the water.

The extensive planting of shelter (tree) belts and the excavation for artificial ponds throughout the drought area, together with the damming up of various creeks and rivers, has been advocated by many as a solution for increased precipitation. While the writer considers the proposals a decided improvement towards the living conditions in the area, he does not consider that they will have any appreciable effect on precipitation in the area referred to.

Shelter belts will collect and hold any winter precipitation in the form of snow and tend to retard their melting in the spring thereby giving the soil in their immediate vicinity better chance of absorbing the collected moisture.

This, together with cultivation and selection of crops tending to replace the fibre in the soil, which has been removed by years of cultivation in one case and the supplying by proper selection of crop and proper working the fibre which is lacking in other sections, will do much towards the prevention of soil drift.

Where no water supply is available, the excavation of ponds for collection of water for domestic use, and for stock watering purposes where only sufficient potable water is obtainable for domestic use is one which has been in use in Manitoba for some years. In the writer's opinion, a good pond on any farm not situated on a creek bank or lake having an all-around water supply, is one of the best assets a farm can have.

Ponds for this use, it will be easily seen, are not of much use for any other purpose. The very object for which they are excavated, namely, that of retaining an all-around water supply, excludes them from the category of a percolation bed and evaporation must be kept at a minimum.

The conclusions arrived at relative to the effect of trees and water have been reached after a number of years of observation of the area situated between Lakes Manitoba and Winnipeg where evaporation surfaces and bush are provided by nature to an extent that it is economically impossible to equal by artificial means and yet in this area lakes and sloughs are drying up without artificial drainage and drought conditions existing, although not on as large a scale as in the dried out areas of the prairie provinces.

The present is not the time for the launching of an extensive tree planting programme as sufficient moisture to start growth of any tree is lacking. However, experiments should be carried on to decide on the tree which will thrive on the minimum of water. When the selection of suitable trees and shrubs has been made, seedlings should be started at once in such numbers than when conditions in the drought area are suitable for proceeding with the project the necessary supply will be available.

On this, together with the attention which the individual is prepared to give, will depend the success of the venture, otherwise the amount of water required to secure a shelter belt may outweigh its usefulness in prevention of soil drift.

The excavation of ponds under present soil and moisture conditions is not feasible. Before sufficient water to fill ponds is available excavations will be filled with drift soil. When ponds are excavated spoil banks should be levelled at once, seeded and surrounded by trees for dual purpose of catching snow and that of preventing soil drift reaching the excavation.

The problem is one of national importance and should have the support of all governments, Federal, provincial and municipal, together with that of the individual.

The attention of the best engineers, agriculturists and geologists should be given to the correlating of all available data and the securing of additional information to arrive at a sound basis for the conservation of available moisture. Particular attention should be paid to the sources by which the ground water of the upper or crop producing strata is supplied, the manner in which it can be conserved and made available to the residents in various areas, also to advise on the best farming methods whereby the individual can co-operate to the utmost in securing the desired results. In the writer's opinion the co-operation received from the individual in carrying out the corrective measures decided upon as being necessary will have more to do with the success or failure of the undertaking than will the major works such as damming of creeks and rivers which will have to be undertaken by one of the governing bodies.

The effect of cultivation on the amount of moisture in the soil was demonstrated last fall during the laying of some two miles of water main. A record was kept of the moisture conditions and the following found to exist:—

On cultivated land which was cropped the same year, moisture was down 8 inches.

On a section which has had a grass coverage for the last twenty years, moisture was down 23 inches.

[18] Chief Engineer, Reclamation Branch, Department of Public Works, Manitoba, Winnipeg, Man.

On a section which was well cultivated, in fact was a large root garden and which had not been cropped for two years, but with the soil well worked and in good condition, the moisture was down 8 feet.

These results were obtained in the vicinity of Winnipeg on approximately a one-quarter section of land.

Another phase which has been greatly emphasized and more particularly in respect to Manitoba, is that of drainage. In the writer's opinion, there are two classes of water:—

That of which the conservation would increase production.

That which is collected in basins or depressions and serves no useful purpose relative to the productiveness of the adjoining lands.

In Manitoba the change in evaporation surface due to artificial means has been less than one-tenth of one per cent. Of this amount the greater portion was in an area where the water was not of any benefit to agricultural pursuits tributary to it. The reclaiming of this area has produced some of the finest and most productive lands in western Canada and even with drought conditions as they are to-day, one would be justified in recommending their drainage. In the years of favourable percolation conditions there is little run-off. In years when conditions are not favourable for percolation the retention of the water on the various farms would have to be of such duration that crop grown would, of necessity, be one of rapid growth and early maturity.

Drought is not a new condition in the area under discussion but one which is recorded by many of the early explorers and which will occur again. Therefore, the present problem is that of devising ways and means whereby during the coming period of ample and possibly of excess moisture, such as have always followed drought periods, the excess water over requirements can be conserved to be used in reducing hardships in future drought periods to a minimum.

P. C. Perry, A.M.E.I.C.

Probably the keynote of the discussion has been the urging of thorough study by experts in the various sciences involved, and citizens in general are probably in agreement with that viewpoint. Some of those participating in the discussion suggested that nothing should be done until a complete study had been made. The writer, however, is convinced that considerable work in connection with development of local water supplies can be proceeded with immediately while the general situation is being more carefully considered. A programme somewhat similar to that carried on by the United States Federal Emergency Relief Administration and described by Mr. Jones can be carried on in the prairie provinces with reasonable assurance of success. A particularly attractive field exists in the construction of municipal reservoirs to supply water and ice for residents of the district. At least nine such reservoirs were constructed in Saskatchewan with engineering supervision last year and it is believed that more were developed without expert advice. Investigations have been made for about forty reservoirs on which work could be done early this year.

It is appreciated that the run-off from the prairie is light and that it can not be depended upon every year. Nevertheless, successful reservoirs have been used for many years by individuals, municipalities, and the railways. The possibilities of this type of work have been demonstrated by experience gained from the time the west was first settled, while the value of these local supplies is beyond question.

The proposals for utilization of the Saskatchewan river are made more attractive because of the more dependable flow of that stream. On the other hand, the river does not possess natural storage basins and the storage of the flood waters will be extremely costly. It seems to be the opinion of those best informed on the matter that large scale irrigation can not be made to pay its own way on the Canadian prairie. The advocates of irrigation in some instances urge that the country at large can bear part of the cost because of the general benefits. In this connection, however, it should be remembered that it is impossible to provide irrigation water for every farm, and if the country assumes part of the cost of irrigating some areas, the farmer without water will be paying (through taxes) part of the cost of the water used by the irrigationist.

Mr. Patterson raised the question of possible mineralization of water in prairie reservoirs, and it may be mentioned that the railways have given careful consideration to that phase of the question, and believe that it is not a serious drawback. The lakes and sloughs have probably developed their mineral content through thousands of years and ground water acquires its mineral salts by slow movement through highly mineralized soil. The greatest help in avoiding mineralization in artificial reservoirs, is to have them located in coulees where the run-off occurs early and for a short time in the spring. A minimum of mineralization occurs when the water runs over frozen ground.

A further great help can be provided in most cases by installing a scour pipe in the dam. Such a pipe is provided with a valve which may be opened when the fresh water begins to enter the reservoir in the spring. In this way an accumulation of salts from year to year is avoided.

Mr. McGavin draws attention to the variety of opinions concerning effect of trees on run-off. Probably the difference in conclusions of observers are due to the differences in other conditions. It is possible that in tropical areas where tree growth is rapid and continuous throughout the year that they may use in transpiration more water than is conserved by shelter in which case the net results would be a reduction in run-off. In higher latitudes the shelter of the trees conserves water for six or seven months and use in transpiration during the remaining part of the year is not great, the net result being an increase of run-off. Further study has led the writer to believe that throughout most of the Canadian area the presence of trees tends to increase the flow of streams. The quotations which Mr. McGavin gives from Professor D. W. Mead, can hardly apply to annual flow for he gives a table* of run-off and precipitation which shows run-off for the Wisconsin river as being 65 per cent of precipitation. In that table, the streams having partly forested watersheds show much heavier percentage of run-off than the prairie streams. The lowest percentage given is for the Platte river of Nebraska where only 8 per cent of the precipitation is included in run-off.

In regard to hedges and shelter belts for the prairie, it is agreed that they will use some water in their growth, and conserve some through reduction of wind. The difference of opinion lies in the question as to which may be the greater, but an important consideration, perhaps not fully recognized, is that the shelter belt may be used to concentrate moisture from the snow-fall in a desirable location. A plot of ground enclosed with hedges or tree belts may collect snow from a large adjoining area not protected. If the topography is favourable, the water from the melting snow may be held, providing the required moisture from the shelter belt and a surplus for crops on a small area or the filling of a small reservoir. The possibility of success in such work will, of course, decrease with attempts to protect all fields with hedges.

L. P. Rundle, M.E.I.C.[19]

Proper remedies for drought conditions are a problem for science and engineering, and the writer offers the following suggestions:

The Federal government to form a commission consisting of expert engineers and scientists, experienced in hydro-electric engineering, forestry, meteorology, irrigation, water conservation and agriculture.

This commission to keep in touch with an engineer representative of each of the provinces involved, and to investigate and correlate all scientific and engineering data, no matter from what source, and to formulate formal recommendations and to finally supervise and direct whatever measures are decided on.

To study reclamation works that have been completed and to exchange ideas with those bodies who are now doing similar works in the United States.

To form an international meteorological clearing house for Canada, the United States, Mexico and the Central American states.

To investigate the effect of hedge and tree planting and the filling of sloughs and swamps, of drainage, etc.

To study the possibilities of vegetation and long root grasses that require a minimum of moisture for those sections that may be determined as being unfitted for settlement or farming.

To determine what areas are not fitted for agricultural purposes with the idea of closing these for settlement and to consider the feasibility of planting trees in such areas.

Outside of proved yearly wheat belts, that is those not subject to drought cycles, to forget wheat and concentrate on mixed farming of a suitable type.

To study regulations with the idea of prohibiting the draining of sloughs, swamps, lakes, etc., with an extensive study made of the geology of the drought areas as it affects the source of ground water, and the scientific regulation of the drilling of wells.

A complete survey of the possibilities of the generation, transmission and distribution of electric energy in conjunction with storage dams and regulating works and other reclamation works.

An intelligent study of road design and engineering to form part of the whole work.

To formulate standard practices and uniform legislation among the various provinces concerned in regard to the handling of water in its various phases.

To formulate an intelligent understanding of the problem by our legislators and the public at large. Where conservation of water by storage dams, etc., and reclamation of land by irrigation and other means in our western drought areas can be proved to be a desirable national undertaking, the public should be shown that any such projects properly directed represent a constructive policy of social development.

Since any reclamation work is a matter that concerns several provinces, it must be engineered by the Federal government with the help of the provinces concerned and a proper division of work decided upon.

The financing of any such work could be fairly divided between the Federal and provincial governments in proportion as the work is purely Federal in scope or local and provincial, though fitting in as part of the general scheme.

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* On page 65 of Professor Mead's book, "Hydrology."

[19] Senior Assistant Engineer, Welland Ship Canal, St. Catharines, Ont.

R. S. Stockton, M.E.I.C.[20]

The agricultural utilization of the dry belt of Alberta and Saskatchewan is of outstanding importance and is an engineering as well as a farm problem. In this great area, nearly 400 miles east and west and perhaps 200 miles wide, there are millions of acres of prairie soil that have been broken by the plough and continuously farmed for grain production.

In many places one-crop grain farming has been so extensive and continued over so many years that the humus or vegetable fibre in the soil has been used up and the result is reduced fertility and drifting soil. Such exhausted soils are also much less retentive of moisture, which is a vital matter in this region. Destruction of the productivity of large areas is taking place, mainly through soil drifting, and the most basic resource of the country is being rapidly dissipated.

This problem is of great concern for the future, since the productive value of the soil is the foundation on which the population may be supported.

The problem of soil drifting extends into the area of greater rainfall and is most serious throughout the great plains region to the south, as well as in the north.

The following remedies have been proposed:—

(*a*) Strip farming for grain, cover crops, and proper cultural practices that will keep the soil furrowed or rough.
(*b*) Building up humus by seeding large areas to native and tame grasses as a permanent method of utilizing the land and also as a crop rotation with grain.
(*c*) Carrying a reasonable number of livestock on the farms and using the manure to build up the soil.
(*d*) Conservation of the available run-off water from all streams and rivers and all drainage areas and using it, as far as possible, to promote plant growth.
(*e*) The planting of trees and shrubs to break the winds, as well as for beauty and for the timber produced.
(*f*) The scientific and careful classification of the land for its best use. The division of the land into farm units of such size that a family can do well on them and adopt the system more useful in each case. It may happen that 40 acres of good irrigable land is worth as much as a township of desert or mountain grazing land.
(*g*) The introduction, selection, breeding and propagation of plants most suitable to our climate and conditions. Some wonderful things have been accomplished but the field is only scratched along these lines.
(*h*) Reducing and adjusting land taxes so as to encourage proper land use and make up any deficiency in necessary tax revenue by increasing the tax on expenditure and dividing this increase, as required.

The conservation and disposal of the water resources of the country is largely an engineering question and includes a wide field of usefulness in the land utilization.

There is first, the proper diversion of perennial streams for direct irrigation of the most suitable areas, with emphasis on economical use and spreading the water over large districts, with maximum production for water and district rather than maximum yields per acre irrigated as the goal.

A second problem has to do with the construction of reservoirs to retain flood water for irrigation and for domestic and power use. It is usual to consider domestic use as first, irrigation as second, and power as the third use, with some allowance for riparian rights, unless these have been abrogated by law in the interest of the state.

A third method of water conservation consists in the proper storage and utilization of storm water on the farms, particularly in the drier portions, where much of the land should be kept in grass and only the choicest portions farmed. In such districts small reservoirs should be built and the gentle slopes and depressions protected by contour dikes about 18 inches to 24 inches high so that there is no storm water run-off lost. The topography should be studied and suitable depressions converted into shallow springtime ponds that later in the season become hay meadows.

The fourth development consists in digging or boxing wells wherever groundwater can be found to yield a supply. A rate of pumping should be adopted that will utilize, but not exhaust, the perennial supply.

The recent public attention to soil drifting, drought and water conservation is most opportune and will greatly strengthen the hands of those who have been working for years to arouse this public concern in order that action may be taken and our country saved.

The farmer on irrigated land does have some particular problems of his own.

In the first place, he must grade, smooth and ditch his land for economical irrigation; he must see that water is applied to his crops at the right time and in approximately the correct amount and without undue waste. Later he may be faced with seepage, water logging and the rise of alkali which results in the loss of some land or an expenditure for drainage and reclamation. Many farmers in a new country, such as this, are greatly hampered by lack of capital; sometimes they lack knowledge of irrigation and in the semi-humid areas they often prefer to follow an extensive system of grain farming on a dryland summerfallow system using irrigation as a last minute resort in a dry season. This is a very crude system of irrigation farming, and except on the best natural slopes, results in very moderate returns, especially as such farmers are nearly always late in irrigating. Such irrigation on rough land increases seepage and alkali difficulties. The best remedy is a small farm unit, or at least a small irrigable area, on which the operator will be forced to strive for the high yields and varied crops that are to be had from properly irrigated farms. Alfalfa and forage crops are usually the basis for irrigation farming, because they require about twice as much moisture for maximum returns as do grain crops and therefore make full use of this control of moisture in the soil. Irrigation lends itself to raising fruit, sugar beets and a great variety of special crops.

The irrigation farmer has the problem of co-operating with his neighbour and the ditch-rider in order to secure water in proper rotation and in quantity to permit of rapid and effective irrigation.

The problems of the irrigation farmer are closely related to the problems of the irrigation district or ditch company and the operating staff. There is not time to discuss these problems in detail, except to say that they centre upon the effort to give good water service at low set cost and to collect the costs of operation and maintenance and pay off the bonded debt, if such exists. The tendency is more and more, as it should be, to place operation of the project and all responsibility on the farmers that use and benefit from the water delivered. They should be organized as an irrigation district and run the irrigation system.

In conclusion, it may be said that the problems of the farmer, in general and as related to irrigation and water conservation, which have been outlined so briefly here, do deserve study, analysis and the working out of practical reforms for they involve the development and safeguarding of our great natural resources. A planned development based on technical surveys and information of the most scientific and complete character would be of the greatest benefit to this vast region.

[20] Manager, Canadian Pacific Railway Experimental Farm, Strathmore, Alta.

Committee on Western Water Problems

Appointed by Council at its meeting held on February 22nd, 1935.

G. A. Gaherty, M.E.I.C.—*Chairman*
President, Montreal Engineering Company Limited,
Montreal.

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Deputy Minister of Mines and Natural Resources,
Winnipeg, Man.

Dr. Charles Camsell, M.E.I.C.,
Deputy Minister of Mines,
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L. C. Charlesworth, M.E.I.C.,
Director of Water Resources, Alberta,
Edmonton, Alta.

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Chief Hydraulic Engineer,
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The Technical Aspect of the Western Drought Problem

The interest shown by members of The Institute in questions vitally affecting national welfare was strikingly shown by the large attendance at the professional session of February 8th, 1935, at the Annual Meeting in Toronto, when a series of papers on the water supply of the prairie provinces was presented and discussed. These papers, which are published elsewhere in this issue of The Journal, together with the discussions thereon, were contributed by engineers and technical authorities well qualified to speak on their respective subjects. They dealt with questions of climatology, physiography, and water conservation, rather than with the strictly agricultural or economic features of the drought problem. In fact, the primary object of Council in arranging for this symposium was to bring out the basic facts in regard to the technical side of the question, and to present them for the guidance of the public in considering and appraising the various schemes of rehabilitation which have been proposed.

It is now realized that a considerable proportion of the southern part of the prairie provinces consists of semi-arid land, in which the water supply in normal years is barely sufficient for the staple crop, wheat, and which is subject to recurrent periods of less than normal, and greater than normal, precipitation. A period of the former kind has now lasted for some six years, with serious consequences to the three prairie provinces and to Canada as a whole, and it is necessary, in the words of the Premier of Manitoba, "to plan now or suffer again." Mr. Bracken has pointed out that the problem of drought is no longer one for individual farmers or a few communities, nor a problem for individual provinces or states, but is a matter of concern to the nation. A glance at conditions in southern Alberta, southern Saskatchewan and south-eastern Manitoba will show the magnitude of the problem in Canada; the extent of the difficulty in the drought area of the United States, which extends from the Canadian boundary to Texas, may be gauged from the fact that the Federal Emergency Relief Administration appropriated over $500,000,000 for relief measures during the year 1934-35 in that region. It is true that the rehabilitation of such areas is essentially an agricultural question, in that much of the necessary remedial work will involve agricultural adjustment, changes in farming practice, the reversion of some arable land to pasture, and possibly even the abandonment of certain cultivated areas. These matters are the concern of the agriculturist rather than the engineer.

The agricultural side of the question has naturally been given prominence in addresses by public men, both Federal and Provincial, and in the many articles which have appeared in the public press. Mistakes in land utilization and development have been made in the past, and it is believed that present cropping methods need reconsideration and redirection in the light of present knowledge. "Some of the virgin soils have been tilled," says Mr. Bracken, "until we have injured their texture. Some soils have been ploughed that should never have been broken." Further, the public has been rightly concerned with the provision of immediate relief for the farmers in the drought area, involving aid for human beings as well as for livestock, and there has been a generous response to the appeals for help which have been issued.

It is obvious that since agriculture in the west is dependent on the available water supply, such relief measures and changes in agricultural policy, however desirable in themselves to alleviate present suffering, will not provide security for the future. For this purpose the available water supply must be conserved and utilized to the best advantage, and this is where the engineer can help.

There are those who believe that unless proper measures are taken without delay, particularly with reference to the conservation of water and the limitation of soil-drifting, there is real danger that extensive areas of actual desert may develop in our Canadian west. An active programme of water conservation and utilization is therefore needed, and is receiving attention. In planning such a programme many technical problems arise, to solve which the aid of the scientist and the engineer is required. In order that reliable technical advice may be prepared, it is necessary first to ascertain the basic facts as to the amount and nature of the water supply available, and, secondly, to indicate the lines along which efforts for the conservation and utilization of that supply must be directed. In some cases schemes involving extensive engineering works and corresponding expense have been put forward without adequate preliminary study by any qualified persons. In other cases projects have been suggested whose feasibility seems very doubtful when they are examined in the light of technical knowledge. Thus general support is sometimes secured for the expenditure of public money on schemes advocated by persons who have no idea of the engineering and financial difficulties which their execution would involve. It is in connection with such matters that the engineer and technical expert can render invaluable service to the public.

There are many debatable questions which arise when the water conservation problem in the west is studied. For instance, to what extent has artificial drainage of the land contributed to our difficulties? During the past twenty years large areas have been drained for reclamation purposes (two million acres in Manitoba). Further, the farmers have drained their land with a view of making it possible to commence tillage operations as early as possible in the spring. The run-off has also been increased by the drainage operations incidental to the construction of highways and railways. To what extent have these operations contributed to our difficulties, should they be limited in the future, and if so, to what extent? As another example take the question of the degree to which the ground-water supply in the drought area is being depleted or polluted by uncontrolled well-drilling. Is this a serious matter, and if so, how can it be dealt with?

Again, how can sufficient water be made available for the individual farmer in the dry area to enable him to grow vegetables, raise live stock, and enjoy a more comfortable standard of living? Is any general scheme of rural water supply feasible, and, if so, from what sources and over what areas?

These and other similar questions must be considered before giving detail study to the major and minor water conservation projects which have been proposed.

Following a suggestion made during the discussion at Toronto, the Council of The Institute has appointed a representative committee who are asked to follow up the work of the Annual Meeting and collect relevant data on the various technical aspects of the subject in consultation with engineers who are in a position to give authoritative information. It is also thought that the committee should confer with agriculturists, foresters, geologists, meteorologists and other experts as may be found necessary, and then give consideration to the various methods of water conservation and utilization which have been suggested. In this way The Institute committee can be of assistance in advising as to those engineering features of the programme for alleviating conditions in the affected area which would be the most promising of success. In doing so, those projects could be indicated which seem feasible and worthy of detailed planning and investigation on the part of the governmental bodies concerned. The carrying out of any programme based on such schemes would of course not be the work of the committee, but of the technical officers appointed by the various governments for that purpose. The assistance of the committee is being offered to the Federal and Provincial authorities, with the intimation that although the problem is primarily agricultural, engineers can help in collecting reliable information and expressing opinions on those remedial measures which involve engineering work or investigation.

Past-Presidents' Prize 1934-1935

The subject prescribed by Council for this competition for the prize year July 1st, 1934, to June 30th, 1935, is

"The Co-ordination of the Activities of the Various Engineering Organizations in Canada."

The rules governing the award of the prize are as follows:

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved as the case may be.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July first to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received **not later than June 30th, 1935**, by the General Secretary of The Institute, either direct from the author or through a local Branch.

Students' and Juniors' Prizes

Students and Juniors of The Institute are reminded that five prizes each of the value of twenty-five dollars, may be awarded to Students and Juniors of The Institute for the prize year 1934-1935 as follows:

The H. N. Ruttan Prize in the four Western Provinces.

The John Galbraith Prize in the Province of Ontario.

The Phelps Johnson Prize for an English Student or Junior in the Province of Quebec.

The Ernest Marceau Prize for a French Student or Junior in the Province of Quebec.

The Martin Murphy Prize in the Maritime Provinces.

Papers in competition for these prizes must be received by Branch Secretaries before June 30th, 1935. Further information as to the requirements and rules may be obtained from the General Secretary.

The Work of the Committee on Consolidation

The Committee appointed at the Annual Meeting of The Institute held in Toronto on February 7th, to develop the possibilities of consolidation of the engineering profession in Canada, held its first meeting in the Royal York Hotel, Toronto, on the evening of February 8th. This meeting was attended by the President, four members of the Committee and representatives from several provinces. Gordon McL. Pitts, A.M.E.I.C., was appointed chairman of the Committee, and Robert F. Legget, A.M.E.I.C., secretary, and there was a general discussion of the procedure to be followed by the Committee.

A further meeting was held in Montreal on February 16th, at which the programme of the Committee was considered, and Professor R. E. Jamieson, M.E.I.C., was added to its number. It was decided that a letter be issued to the Secretaries of the Branches of The Institute and of the Professional Associations, advising them of the functions and programme of the Committee, together with a review of the action taken by the various Branches and Associations throughout Canada on the matter of consolidation.

The chairman and secretary of the Committee were invited to attend a meeting of Council held at headquarters on Friday, February 22nd, at which time the proposals of the Committee were explained to the Council and its progress to date reviewed.

The third meeting of the Committee was held in Montreal on March 1st, and Dr. O. Lefebvre, M.E.I.C., was added to its membership. It was reported that the brochure on the "Proposed Consolidation of the Engineering Profession in Canada" had been distributed to all the members of The Institute, with a covering letter explaining that its purpose was to provide a basis for discussion. It was decided that the Committee should circulate as widely as possible all suggestions or criticisms that they may receive from various engineering organizations, with the idea of crystallizing a majority opinion into a workable scheme for presentation to The Institute.

The letters suggesting a general method of procedure in the consideration of this question, together with a report on the resolutions on this subject from the various engineering bodies throughout Canada, and a chart indicating the organization of the Provincial Committees for discussion and suggestions, have gone forward. Replies to the above indicate that Nova Scotia already has a Joint Committee on Amalgamation, and has, by an almost unanimous vote, made a definite move toward the setting up of one engineering organization in that province which will include members of the Branches of The Institute and of the Professional Associations.

In New Brunswick the Professional Association has gone on record as being in favour of consolidation, and the Annual Meeting of the Saint John Branch will be held on May 9th, at which time their action on this matter will be considered.

In Quebec The Institute Branches in Montreal and the city of Quebec have passed resolutions favouring consolidation. The Saguenay Branch has expressed itself as favouring such action. The Annual Meeting of the Corporation of Professional Engineers of the Province of Quebec held on March 27th, received the unanimous report of a Committee which took the form of a resolution to the meeting favouring co-ordination of the various engineering bodies in Canada with The Institute functioning as the national organization. This motion was passed with few dissenting.

In Ontario, organization work has been slower, but the sentiment expressed is strongly in favour of the principle of consolidation and definite approval of that principle has been received from the Border Cities Branch, the Hamilton Branch and the Ottawa Branch.

In Manitoba, the attitude of the profession towards consolidation, as reflected in the recent referendum, is well known, and the Winnipeg Branch has recently appointed a Committee of five, to represent them in discussions on this subject.

In Saskatchewan, probably greater progress has been made than in any other province with the exception of Nova Scotia, and a Joint Committee has already been formed under the chairmanship of D. A. R. McCannel, M.E.I.C., who is also a member of the Associations' Committee of Eight and appointee to the Central Committee on Consolidation. The Saskatchewan Branch went on record on March 22nd, as being in favour of a national engineering body to represent the whole engineering profession in Canada.

In Alberta, the Lethbridge Branch are strongly in favour of consolidation and the other organizations in that province have indicated that they have this matter under consideration. The Calgary Branch of The Institute has just appointed a Committee of five on consolidation under the convenership of Mr. R. S. Trowsdale, A.M.E.I.C.

With regard to British Columbia, the Victoria Branch of The Institute has passed a resolution strongly in favour of consolidation between The Engineering Institute of Canada and the various Provincial Associations of Professional Engineers.

Mr. R. F. Legget, the secretary of the Committee, has just returned from a two weeks' trip to the Maritime Provinces, during which he visited Moncton, Cape Breton, Halifax and Saint John. He reports the Maritime Provinces strongly in favour of consolidation.

The Committee urgently requests every Branch to meet as promptly as possible to discuss this question and to form their Joint Committees to co-operate with the central Committee, and to forward their suggestions and criticisms for circulation to other bodies, and otherwise to maintain a constructive consideration of this important matter so that a decision may not be delayed and that the provinces may be in a position to act concurrently.

The Committee solicits the co-operation of members of The Institute, individually and collectively, in the best interests of the profession throughout Canada.

E.I.C. Prizes for Canadian Engineering Colleges

At the February meeting of Council it was decided to renew for a further period of five years The Engineering Institute of Canada Prizes, which The Institute has given during the last five years to eleven of the principal engineering schools in the country. Council has received letters of appreciation regarding the award of these prizes, which have a value of Twenty-Five dollars each, and are offered annually for competition among the registered students in the year prior to the graduating year in the following universities and colleges:

University of Alberta
University of British Columbia
Ecole Polytechnique, Montreal
University of Manitoba
McGill University
University of New Brunswick
Nova Scotia Technical College
Queen's University
Royal Military College
University of Saskatchewan
University of Toronto

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Tuesday, March 19th, 1935, at eight o'clock p.m., with President F. A. Gaby, M.E.I.C., in the chair, and twelve other members of Council present.

Discussion took place on the proposals which have been made in Nova Scotia for the closer union of the Association of Professional Engineers of Nova Scotia and The Institute branches in Nova Scotia, during which it was pointed out that the problem of co-ordination of the engineering profession in Canada was referred by the last Annual Meeting to a committee under the chairmanship of Mr. Gordon McL. Pitts, A.M.E.I.C. The Secretary was directed to draw the attention of The Institute branches in Nova Scotia to this fact, and to place such information as is available regarding the situation in Nova Scotia in the hands of Mr. Pitts' committee.

The membership of the committee appointed by Council to develop activities in The Institute of interest to communication engineers, as submitted by Professor Wallace, was approved as follows, it being noted that additional names would be submitted at a later date:

G. A. Wallace, A.M.E.I.C., *Chairman.*
J. L. Clarke, M.E.I.C.
S. T. Fisher, Jr.E.I.C.
W. A. Steel
J. H. Thompson, A.M.E.I.C.
H. J. Vennes, A.M.E.I.C.

Letters were noted from the deans of the engineering schools in the several Canadian universities expressing appreciation of Council's action in continuing the award of The Engineering Institute of Canada Prizes for a further period of five years.

It was noted that the following members of The Institute had been asked to serve on the committee appointed by Council to give further consideration to the study of the western water problem:

C. H. Attwood, A.M.E.I.C., Winnipeg, Man.
Dr. Charles Camsell, M.E.I.C., Ottawa, Ont.
L. C. Charlesworth, M.E.I.C., Edmonton, Alta.
Dr. T. H. Hogg, M.E.I.C., Toronto, Ont.
Dr. O. O. Lefebvre, M.E.I.C., Montreal, Que.
Dean C. J. Mackenzie, M.E.I.C., Saskatoon, Sask.
S. G. Porter, M.E.I.C., Calgary, Alta.

The membership of the Library and House Committee was approved as follows:

E. A. Ryan, M.E.I.C., *Chairman.*
J. L. Clarke, M.E.I.C.
F. E. V. Dowd, A.M.E.I.C.
W. G. Hunt, M.E.I.C.
J. H. Landry, A.M.E.I.C.

The examiners for the Students' and Juniors' Prizes were appointed as follows:

H. N. Ruttan Prize	E. V. Caton, M.E.I.C., *Chairman.*
	H. R. Webb, A.M.E.I.C.
	A. S. Wootton, M.E.I.C.
John Galbraith Prize	E. G. Cameron, A.M.E.I.C., *Chairman.*
	F. W. Paulin, M.E.I.C.
	A. E. Pickering, M.E.I.C.
Phelps Johnson Prize	P. L. Pratley, M.E.I.C., *Chairman.*
	C. B. Brown, M.E.I.C.
	E. A. Ryan, M.E.I.C.
Ernest Marceau Prize	A. B. Normandin, M.E.I.C., *Chairman.*
	H. Cimon, M.E.I.C.
	B. Grandmont, A.M.E.I.C.
Martin Murphy Prize	A. Gray, M.E.I.C., *Chairman.*
	H. J. Crudge, A.M.E.I.C.
	H. S. Johnston, M.E.I.C.

Discussion took place on the general policy to be pursued in the case of members in arrears or on the Non-Active List.

Consideration was given to a request from the Calgary Branch that the payment for branch news in The Journal be resumed, but on a report from the Finance Committee it was decided that such payments could not be resumed as yet.

A number of suggested revisions to the Niagara Peninsula Branch By-laws were noted and approved.

Twelve resignations were accepted, a number of members were placed on the Non-Active List, several special cases were considered, one member was reinstated, and one member placed on the Life Membership List.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

Elections		*Transfers*	
Members	3	Assoc. Member to Member	2
Associate Members	6	Junior to Assoc. Member	5
Affiliate	1	Student to Assoc. Member	4
Students admitted	24	Student to Junior	3

The Council rose at eleven fifteen p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on March 19th, 1935, the following elections and transfers were effected:

Members

DUFRESNE, Alphonse Olivier, B.A.Sc., M.E., (Ecole Polytechnique, Montreal), B.Sc., M.Sc., (McGill Univ.), director, Quebec Bureau of Mines, Quebec, Que.

MARTINEAU, Joseph Omer, B.Sc., (Queen's Univ.), asst. chief engr., Dept. of Roads, Quebec, Que.

PARADIS, Alphonse, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), chief engr., Dept. of Roads, Quebec, Que.

Associate Members

COXWORTH, Thomas Walker, B.Sc., (Univ. of Man.), asst. engr., McClintic Marshall Corpn., Chicago, Ill.

GAGNON, Ludger, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), asst. city engr., Quebec, Que.

GALE, Melvin Lambeth, B.Sc., (Univ. of Alta.), assessor, Province of Alberta, 12021-97th Street, Edmonton, Alta.

HESLOP, Wilfrid Gibson, B.A.Sc., (Univ. of Toronto), P.O. Box 196, Kirkland Lake, Ont.

MATTHEWS, Samuel, B.Sc., (Univ. of Sask.), ceramic engr., Dominion Fire Brick & Clay Products, Ltd., Moose Jaw, Sask.

SCRYMGEOUR, Donald Stuart, (Royal Technical Institute), chief dftsman., London Structural Steel Co. Ltd., London, Ont.

Affiliate

MacFARLANE, Peter William, supt. engr., bldgs. and grounds, McGill University, Montreal, Que.

Transferred from the class of Associate Member to that of Member

BENNETT, Harry Frederick, B.Sc., (Univ. of N.B.), district engr., Dept. of Public Works of Canada, Sault Ste. Marie, Ont.

LINTON, Adam Pearce, B.A.Sc., (Univ. of Toronto), chief bridge engr., Dept. of Highways of Sask., Regina, Sask.

Transferred from the class of Junior to that of Associate Member

CARRUTHERS, Clarence D., B.A.Sc., (Univ. of Toronto), designer and dftsman., for Gordon L. Wallace, A.M.E.I.C., Toronto, Ont.

DAVIDSON, John Knox, B.Sc., (Univ. of St. Andrews, Scotland), A.M.I.C.E.; chief engr., Electric Reduction Co. Ltd., Buckingham, Que.

GRAHAM, Walter White, B.Sc., (McGill Univ.), elect'l. designer, Shawinigan Engineering Company, Montreal, Que.

LAIDLAW, Douglas Staunton, B.A.Sc., (Univ. of Toronto), struct'l. engr., in partnership with Catto & Catto, architects, Toronto, Ont.

LOVETT, Percy Arthur, B.Sc., (N.S. Tech. Coll.), consltg. engr. and sec. treas., Engineering Service Co. Ltd., Halifax, N.S.

Transferred from the class of Student to that of Associate Member

ARMSTRONG, Owen Fred Calder, B.Sc., (N.S. Tech. Coll.), asst. to gen. employment supervisor, gen. traffic dept., Bell Telephone Company of Canada, Montreal, Que.

COSTIGAN, James Percival McDougall, B.Sc., (McGill Univ.), engr., T. Pringle & Son Limited, Montreal, Que.

HURST, William Donald, B.Sc., (Univ. of Man.), C.E., (Virginia Polytechnic Inst.), asst. engr. (in charge of water works operating branch), City of Winnipeg, Man.

SCANLAN, Jeremiah Joseph René, B.Sc., (McGill Univ.), engr., Milton Hersey Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Junior

LEWIS, Edmund Keith, B.Sc., (N.S. Tech. Coll.), in charge of meter dept., Imperial Oil Refinery, Dartmouth, N.S.

STRIOWSKI, John Benjamin, B.Sc., (Univ. of Man.), 257 Beverley St., Winnipeg, Man.

WICKWIRE, Lawrence David, B.Sc., (N.S. Tech. Coll.), engrg. dftsman., Mersey Paper Company, Liverpool, N.S.

Students Admitted

ANGEL, John Bartlett, (McGill Univ.), 3609 University St., Montreal, Que.

BEACH, John Edward, (Univ. of Alta.), 10957-90th Ave., Edmonton, Alta.

BEATH, Laurence Raymond, (McGill Univ.), 1492 Bishop St., Montreal, Que.

BURKE, Eric Vincent, (Memorial University College), 38 Bonaventure Ave., St. John's, Nfld.

CHEESEMAN, Edgar W., (Memorial Univ. Coll.), 66 Fleming St., St. John's, Nfld.

DOBSON-SMITH, Charles Fredrick, (Univ. of Man.), Dundurn Camp., Dundurn, Sask.

DUNCAN, Gaylen R., Jr., (McGill Univ.), 1550 Mackay St., Montreal, Que.

ERICKSON, Martin Adolph, (Queen's Univ.), 27 Clergy Street West, Kingston, Ont.

FRIZZLE, Harold Robert, B.Sc., (N.S. Tech. Coll.), Berwick, N.S.

GODDEN, Charles J., (Memorial Univ. Coll.), 55 Cochrane St., St. John's, Nfld.

GORDON, John Edward, (Queen's Univ.), 113 King St. W., Dundas, Ont.

INNES, Edward Patrick N., B.Eng., (McGill Univ.), 56 Charlton Ave. W., Hamilton, Ont.

KENT, A. Douglas, (Queen's Univ.), 148 Barrie St., Kingston, Ont.

McDONALD, Alexander John, (Queen's Univ.), 537 Albert St., Kingston, Ont.

MOAKLER, John J., (Memorial Univ. Coll.), 11 Maxse St., St. John's, Nfld.

MORRIS, S. Rupert, (Memorial Univ. Coll.), Trinity, Nfld.

POWELL, Robert M., (R.M.C.), 290 Coltrin Road, Rockcliffe, Ottawa, Ont.

PARSONS, Clarence Walter, (Memorial Univ. Coll.), Bell Island, Nfld.

REES, Frederic, (Memorial Univ. Coll.). Bell Island, Nfld.

SCHEAR, Philip Maurice, (McGill Univ.), 4215 St. Urbain St., Montreal, Que.

SMITH, Owen Leonard, (Memorial Univ. Coll.), Angle Brook, Glovertown, Nfld.

SOLES, William, (Queen's Univ.), Rock Island, Que.

TATHAM, William Carlyle, (McGill Univ.), 3647 University St., Montreal, Que.

YORK, Frederick Gilbert, (McGill Univ.), 1441 Drummond St., Montreal, Que.

OBITUARIES

Frederick Young Harcourt, M.E.I.C.

We regret to announce the death of Frederick Young Harcourt, M.E.I.C., at London, Ontario, on February 14th, 1935.

Mr. Harcourt was born at Welland, Ontario, on July 31st, 1879, and graduated from the University of Toronto with the degree of B.A. in 1900, and from the School of Practical Science in 1903.

Following graduation he was until 1905 rodman and instrumentman and chief of field party with the Ontario Power Company at Niagara Falls, Ont. In 1905-1907 he was on the Georgian Bay canal survey as instrumentman, and in 1907 he entered the service of the Department of Public Works, Canada, as senior assistant engineer of the Port Arthur district. In 1911-1915 Mr. Harcourt was district engineer of the same district, and from 1915 to 1919 served overseas, returning to the same position at the end of the war. From 1921 to 1930 he was district engineer for the Department of Public Works of Canada of the Port Arthur and Fort William districts, and in 1930 he was transferred to London, Ontario, where he was in charge of the district until the time of his death.

Mr. Harcourt joined The Institute as a Member on May 22nd, 1922, and took a keen interest in Institute affairs, having been elected a Councillor representing the Lakehead Branch in 1930, and served on the Executive committee of the London Branch.

Joseph O. Bonin, A.M.E.I.C.

Regret is expressed in placing on record the death at Cedars, Que., of Joseph O. Bonin, A.M.E.I.C.

Mr. Bonin was born at Lanoraie, Que., on July 29th, 1879, and graduated from Laval University with the degree of B.A. in 1902.

In 1904 Mr. Bonin was rodman with the Canadian Pacific Railway Company and in 1905-1906 was leveller with the New Canadian Company, being engaged on railway construction in summer and surveys in winter. In 1907-1908 Mr. Bonin was again with the Canadian Pacific Railway Company, as transitman on grade reduction, and in 1909-1910 he was resident engineer on railway construction with the New Canadian Company. In the following year he was with the Bishop Construction Company as contractors' engineer. For over twenty years Mr. Bonin has been located at Cedars, Que.

He became a Student of The Institute on October 12th, 1905, and on May 11th, 1912, transferred to the class of Associate Member.

Alfred Boydell Lambe, A.M.E.I.C.

It is with regret that we have to record the death of Alfred Boydell Lambe, A.M.E.I.C., at Ottawa, Ont., on March 15th, 1935.

Mr. Lambe was born at Toronto, Ont., on February 9th, 1873, and received his early education at the Woodstock College where he took a science course, later taking a student's course with the Canadian General Electric Company at Peterborough, Ont.

From 1895 to 1896 Mr. Lambe was superintendent and engineer with the Peterborough Street Railway, and in the following year was assistant chief engineer with the London Street Railway. In 1897-98 he was superintendent and engineer with the Lima (Ohio) Street Railway and from that time until 1903 was engaged on designing, estimating and constructing electric plants of all descriptions as assistant to the chief engineer of the Canadian General Electric Company. From 1903 to 1909 Mr. Lambe was supply department engineer with the same company, and in 1909 he became manager and engineer of the company's Winnipeg district. In 1911 Mr. Lambe became assistant to the chief electrical engineer with the Department of Inland Revenue, Ottawa, and in 1919 he was with the Dominion Power Board. In 1925 he became attached to the Dominion Water Power Branch of the Department of the Interior, Ottawa.

Mr. Lambe was widely known in electrical circles throughout Ontario, and was very active in the affairs of the Association of Professional Engineers of the Province of Ontario, having been president of the Association in 1933.

Mr. Lambe joined The Institute as an Associate Member on April 8th, 1911. He took a keen interest in Institute affairs, and was a member of the Executive committee of the Ottawa Branch in the year 1922-1923.

PERSONALS

C. W. Deans, S.E.I.C., is now connected with the Western Bridge Company, Vancouver, B.C. Mr. Deans graduated from the University of British Columbia in 1930 with the degree of B.A.Sc., and in 1933 received the degree of M.Sc. from Iowa State College.

Lawrence H. Armstrong, A.M.E.I.C., Science 1922, McGill University, son of Professor Henry F. Armstrong, sailed on March 30th on the S.S. Southern Cross for Rio de Janeiro, Brazil, where he will be employed on special work by the Brazilian Telephone Company.

Mr. Armstrong was for eight years with the International Telephone and Telegraph Corporation in Cuba and Spain, most of which time was spent on toll transmission work, and the last two years on trans-Atlantic radio telephone development.

E. L. Dilworth, A.M.E.I.C., of the Canadian Blower and Forge Company Limited, has been transferred to the company's head office in Kitchener, Ont., as assistant sales manager for the company and its associate, Canada Pumps Limited. Mr. Dilworth graduated from Queen's University in 1925 with the degree of B.Sc., and was subsequently with the Buffalo Forge Company at Buffalo, N.Y. He returned to Canada in 1926, and in 1927 took charge of the Montreal office of the Canadian Blower and Forge Company Limited, holding that position until recently.

CORRESPONDENCE

The Editor, Toronto, February 26th, 1935.
The Engineering Journal,
2050 Mansfield Street,
Montreal, Que.

Dear Sir:—

At the recent annual meeting of The Institute in Toronto Mr. J. B. Carswell, M.E.I.C., in his luncheon address, introducing the discussion on the "Status of the Engineer," made some very pertinent and timely observations which merit more attention than they received in the subsequent discussions.

Mr. Carswell in a courageous and forceful speech pointed out that The Institute is devoting all its time to routine matters and the discussion of technical subjects. It is neglecting entirely to interest itself in the general affairs of the community. It offers no opinion, for example, on such matters of urgent national importance as the railway problem; unemployment insurance; relief work and other similar matters on which the government seeks and needs guidance and advice.

He urged a change in policy which would enable The Institute to act as the mouthpiece of the engineering profession in such matters; and he expressed the opinion that the resulting enlargement of "the stature" of the engineer in the public eye would automatically effect an improvement in the status of the engineer in industry, in the public service and in private practice.

Unfortunately the reading and discussion of the three subsequent papers left no time for adequate comment on Mr. Carswell's introduction. It would be unfortunate if his challenging and thought provoking utterances were allowed to pass without further discussion. I would suggest, therefore, that through the medium of The Journal, members would be invited to express their views on this important subject, which has a direct bearing on the declining influence of The Engineering Institute of Canada in recent years.

Unquestionably members of the engineering profession do not occupy the same position nor wield the same influence in public affairs as do the members of other professions. A cursory glance at the constitution of the present House of Commons at Ottawa—or indeed the constitution of any national or local government body—will indicate the negligible representation of our profession in public life.

Admittedly, the nature of the engineer's work, and the fact that so many engineers are employed directly or indirectly by public bodies, railways, public utilities, universities and large corporations, make individual participation in public life impracticable for most of us.

Is it not therefore all the more necessary to have a strong corporate body, fully cognisant of the views of engineers, and capable of presenting and advocating the considered opinion of the engineering profession on questions of the day?

When any matter of great public concern is attracting the attention of the country, it is customary for Boards of Trade, Chambers of Commerce, Manufacturers' Associations, Agricultural Organizations, and similar bodies to convey their views to the government.

Engineers, however, remain inarticulate because they have no mouthpiece through which they can speak, and yet by the nature of their work engineers are brought into intimate contact with every branch of human activity—production—distribution—consumption. Surely they should have something useful to contribute towards the solution of the problems that threaten our social structure—and surely The Engineering Institute of Canada should lead the way.

To the average member, I venture to think, The Institute has ceased to be a live entity—and we have ourselves to blame. With most of us our interest starts and finishes with a perfunctory attendance at a few meetings during the winter months, when we listen to the reading and discussions of technical papers which could generally be more effectively presented in The Journal or in the technical press.

Apart from that—there is little to stimulate interest—little social intercourse—no political aspirations—no contact with public affairs—none of those human relations which are so necessary to build up and sustain an interest in any objective—and which have been instrumental in raising other professional men to their higher standing in the community.

However, if The Institute will arouse itself from its torpor, give ear to the demands of changing conditions, and step out from within the bounds of professional reticence, I am convinced that it can be made useful and influential, not only professionally but also nationally.

Mr. Carswell has indicated the first step. Let us take it.

Yours truly,

(Signed) W. E. P. Duncan, A.M.E.I.C.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Society of Naval Architects and Marine Engineers:
Transactions 1933, Volume 41, and 1934, Volume 42.

American Society of Mechanical Engineers:
Transactions 1934. Volume 56.

Reports, etc.

Canada Dept. of Labour: Trade Union Law in Canada.

Ontario, Bureau of Mines:
Bulletin No. 98, Preliminary Report on the Mineral Production of Ontario in 1934.

Quebec, Province: Statistical Year Book 1934.

Quebec Bureau of Mines:
Preliminary Statement on the Mineral Production of the Province during the year 1934.

Saint John Harbour Commission: Annual Report, 1934.

Rational Calendar Association of Canada: Canada and the Calendar.

Technical Books, etc., Received

The Working, Heat Treating and Welding of Steel, by H. L. Campbell. (*John Wiley and Sons, New York.*)

Mechanics, a text-book for Engineering Students, by Frank Gardener. (*Oxford University Press.*)

The Elements of Specification Writing, by R. S. Kirby. (*John Wiley and Sons.*)

The End of an Era, by L. K. Sillcox. (*The Franklin Institute.*)

Introduction to Electric Transients, by E. B. Kurtz and G. F. Corcoran. (*John Wiley and Sons.*)

The Business Year Book, 1935. (*The Financial Post.*)

Dominion-Crossley and Dominion-Crossley-Premier Diesel Engines

An association has been formed between Dominion Engineering Works Limited, Crossley Brothers Limited of Manchester, and Crossley-Premier Engines Limited of Sandiacre, as a result of which Dominion Engineering Works Limited will manufacture and sell Dominion-Crossley and Dominion-Crossley-Premier Diesel and Gas engines for Canada and Newfoundland.

Engines which may be offered by Dominion-Crossley-Premier will have behind them the long experience of Crossley Brothers and the Crossley-Premier Engine Company as builders of Diesel engines for a great variety of services.

Dominion Engineering Works hopes through its manufacturing facilities in Canada and through its branch offices and associate companies throughout the country, to render a service to users of Diesel engines in Canada and Newfoundland which cannot be rendered so well from abroad.

BOOK REVIEWS

The Stone Industries

By Oliver Bowles, McGraw-Hill Book Co. Inc., New York, 1934. 6 by 9¼ inches, 519 pages, photos, diagrams, etc. $5.00. Cloth.

Reviewed by L. H. Cole, M.E.I.C.*

Few people realize the important part played by stone of all kinds in industry. Its application to practical use was one of the oldest human activities, extending far back before the earliest records, for the name "stone age" is applied to that period of history, our knowledge of which has been conveyed to us only by the crude tools and implements of stone that have been unearthed from time to time.

It is a far cry from the lowly stone hammers and flint arrow heads of our earliest ancestors to the beautifully designed and intricately carved modern buildings to be seen in all our larger cities, and likewise the difference between early quarrying and our present day methods of excavating stone is so great and the advances made in recent years so marked that it is with pleasure that we welcome this volume, giving a comprehensive picture of the stone industry to-day, especially from the pen of an author who has made the subject one of extensive research for so many years.

The volume is divided into three parts: the first part covering the general features of the stone industries; the second, dimension stone, and part three, crushed and broken stone.

Part I deals with the generalities of the industry, has a brief chapter on the minerals and rocks and their classification, and discusses the factors governing rock utilization as well as methods of prospecting and development, points which are common to all classes of quarrying.

Part II, on the production of dimension stone, occupies well over half of the book and deals in detail in separate chapters with the various stones used for the production of dimension blocks, such as limestone, sandstone, granite, marble and slate.

Part III, covering the crushed and broken stone industry, treats principally with crushed and broken limestone, at the same time not neglecting other stones than limestone.

The book, while dealing principally with the stone industry of the United States, contains a brief but well written chapter on Foreign Building and Ornamental Stones.

For engineers and architects, the book has a direct appeal, dealing as it does with the composition, physical properties, structural features, methods of preparation and uses of the various classes of stone.

One criticism that might be offered is the lack of a comprehensive glossary of terms used in the stone industry, a defect that the present volume shares with most other textbooks on the subject. Most of the definitions are given in the text, but if they were compiled in a glossary as an appendix at the end of the volume, this would be of great value.

The bibliographical references at the end of each chapter are wisely chosen and enable easy research over a much wider area than is possible to compress into a volume of this size. The volume is very well indexed, making it extremely valuable as a ready reference book, not least to Canadian engineers interested in the subject, the author having received his engineering education at the University of Toronto.

**Mining Engineer, Mines Branch, Department of Mines, Ottawa.*

An Introduction to Structural Theory and Design

By Hale Sutherland and Harry Lake Bowman, John Wiley and Sons, New York, 1935. 5¾ by 9¼ inches, 318 pages, diagrams, etc. $3.50. Cloth.

Reviewed by W. Chase Thomson, M.E.I.C.*

This is primarily a text-book for use in colleges: but portions of it will be found of interest and value to the practising engineer. As stated in the preface, the reader is assumed to be familiar with the principles of statics and of the strength of materials. It is well written and illustrated.

Simple structures are dealt with very fully in Chapters I to VI inclusive.

In Chapter VII slope and deflection of beams and trusses are treated comprehensively by various methods, including those of work, elastic weights and moment areas, also by the Williot-Mohr diagram.

Chapter VIII deals with rigid frames, introducing the theorem of three moments, also the methods of least work, slope deflection, moment distribution and column analogy.

Chapter IX gives approximate methods only for calculating wind stresses in frames of tall buildings; but, for comparison, includes results derived by the slope-deflection method for a particular example. The authors recommend approximate methods for calculating wind stresses, because of the cumbersomeness of the so-called exact methods, because of the lack of knowledge concerning the proportion of the wind shears carried by walls and partitions and their distribution by the rigid floor construction, also because the girders in steel construction have usually been proportioned as though they were simple spans when carrying vertical loads. With the Cross method of moment distribution now available, which greatly simplifies the layout and by which the same degree of accuracy may be obtained as by the slope-deflection method, there would seem to be no reasonable excuse for approximate methods, either for vertical or horizontal loads. In the meantime, until curtain walls and partitions are better designed to act in unison with the steel

**Consulting engineer, Montreal.*

frame, and until it is possible to make reasonably reliable assumptions regarding the proportion of shears transmitted by such curtain walls and partitions, it would seem advisable to continue proportioning the columns and girders to resist the entire assumed wind loads.

Chapter X deals adequately with indeterminate trusses, employing methods of least work, deflections and influence lines. It closes with a reference to mechanical analysis.

In Chapter XI, secondary stresses are treated primarily by the slope-deflection method as modified by Mohr, using a Williot diagram to determine the movement of the end of a member perpendicular to its axis. Reference is also made to the Cross method, in which the fixed-end moments are obtained by a Williot diagram, as before, but without rotation of joints. Moments are then distributed in the usual manner. The calculation of secondary stresses by the latter method becomes a very simple matter; and, as mentioned by the authors, the accuracy attainable thereby may be as great as desired, or as can be obtained by the Mohr method.

The book closes with Chapter XII, dealing with space framework. This section will be found particularly useful in the design of transmission towers, which are frequently subject to eccentrically-applied loads.

Diesel Engine Design

By Harold F. Shepherd, John Wiley and Sons, New York, 1935. 6 by 9¼ in., 224 pages. $3.50. Cloth.

This publication is well printed and clearly illustrated, but obviously such a big subject cannot be fully covered in a comparatively small volume of this type. It is, however, extremely refreshing to find a treatise on Diesel engines which nowhere contains catalogue descriptions of different makes of Diesel engine.

The first chapter of the volume is entitled "Historical" and might perhaps have been omitted without seriously impairing the value of the book, especially as some of the references are incomplete, for example those dealing with the types of combustion chamber for small engines, in which there is no reference to the direct injection system.

The other chapters deal with such features as combustion, fuel, nozzles and pumps, governing, cylinder heads and valve gear, lubrication, inertia of reciprocating parts, the flywheel and crankshaft with an appendix for reducing calculations in designing crankshaft members, and generally speaking, the whole volume is based on giving short descriptions of the principles involved in the design of each component part of the engine, followed by, in many cases, references to the necessary calculations for solving the problems connected therewith. Some of the illustrations, such as of men lining a room with cork insulating material, or of an exploded crankcase, seem superfluous.

The book is worthy of a much fuller index than is provided. The author cites a number of features in design or material upon which successful operation depends, discussing for example the form and proportions of piston which are needed to secure an optimum working temperature of piston face, and the points to be borne in mind when designing the starting gear for marine engines which are required to manoeuvre constantly in service.

The volume may be recommended as of considerable value to engineers interested in Diesel engines, either from the design or operating viewpoints. It must not be overlooked, however, that there are probably hundreds of different manufacturers of Diesel engines, every one of whom has at least one distinctive method of dealing successfully with some specific problem, and that it is impossible in a volume of this size to refer to more than the small proportion of these many methods which may be personally known to the author.

The 1935 E.I.C. Engineering Catalogue

The third annual edition of the E.I.C. Engineering Catalogue is now in the press and will be distributed shortly. The present volume is considerably extended both as regards the information descriptive of engineering equipment and materials and the index reference data.

The many appreciative letters received following the issuance of the first two editions, and the evident desire of manufacturers to include greater detail regarding their products is indicative of the better understanding and appreciation of the service which The Institute is rendering by the publication of such a comprehensive and authoritative reference book.

In the present issue the arrangement of the data follows that of the previous editions, which is believed to provide the most convenient arrangement for ready reference.

The Catalogue is designed to serve the requirements of those responsible for the specifying and purchase of engineering equipment and materials in every branch of industry and engineering, so that it includes reference information covering electrical equipment, mechanical equipment, construction equipment, building products and special machinery used in such basic industries as mining, pulp and paper manufacture, textiles, etc.

Copies of the Catalogue will be supplied to all members of The Institute who will fill in and return the enquiry cards which will be sent out in the course of a few days, and the remainder of the issue of five thousand copies will be distributed to a carefully selected list of those officers of important firms or organizations who can best make use of the reference information which it contains.

BRANCH NEWS

Calgary Branch

J. Dow, M.E.I.C., Secretary-Treasurer.
H. W. Tooker, A.M.E.I.C., Branch News Editor.

On Thursday, February 7th, 1935, the members of the Calgary Branch were fortunate in hearing an address by Mr. A. Hannah, K.C., on "Democracy or Dictatorship." This meeting was also chosen for the finals of the ten minute speeches in the competition for the younger members of the Branch. Those participating were I. Abramson, Jr.E.I.C., and R. W. Dunlop, Jr.E.I.C.

Cement Testing

The chairman first called upon Mr. Abramson, whose subject was "Cement Testing."

The tests usually applied to cement may be roughly classified as mechanical or chemical in nature, the most common being for the determination of tensile or compressive strength. Fineness, normal consistency, time of set etc., soundness, are also observed and for some purposes porosity and permeability of mortars may be investigated.

However, one test method, the study of electrical properties of cement, seems to be overlooked.

Modern atomic theories regard all matter as electrical in nature and chemical properties of any element may be explained in terms of grouping of the electrons about the atomic nucleus and the resultant internal and external forces. Therefore, a study of the variation in electrical characteristics of a chemical mixture should yield information on the changes taking place in it.

A similar conclusion may be reached by a different form of reasoning, viz. from practice we know that the ohmic resistance of an electrical conductor of given dimensions depends on its chemical composition, thus if chemical changes take place in a given conductor its chemical resistance must vary.

To prove this, a number of experiments were carried out with test pieces having electrodes inserted in the ends of each. After curing in moist air the specimens were transferred to various solutions. At daily intervals they were removed from the solutions, the surfaces dried and the resistance measured by observing the voltage necessary to pass a given current.

Principles of Orifice Meters

The chairman then called upon Mr. R. W. Dunlop for his discussion on the "Principles of Orifice Meters."

To give a very short outline of the principles of orifice meters the subject may be divided into the following general headings:

Uses. Orifice meters have a wide range of application, chiefly in large scale commercial measurements of liquids and gases, and are used for total quantity and rate of flow measurements.

Development and Principles. The orifice meter has been developed from the characteristics of fluid flow through a circular orifice in a diaphram inserted in a pipe. Connections are made on the pipe for measuring differential pressures at the upstream and downstream faces of the plate as well as the static or line pressure at the downstream face. By determining differentials for various flow rates with any orifice we can establish an orifice meter. For compressible fluids it is necessary to measure static pressure at the down stream face.

General Considerations. To obtain consistently accurate results the following considerations must be taken into account: size of orifice relative to pipe size; the fittings should be ten pipe diameters up stream and five diameters down stream from the orifice; position of differential connections; orifice shape.

Following Mr. Dunlap's address the chairman introduced the speaker of the evening, Mr. A. Hannah, K.C.

Democracy or Dictatorship

In his opening remarks Mr. Hannah stated that there was nothing political in what he was about to say and also that he wished to review the subject of democracy in the first place, as this form of government has developed under the British constitution.

One of the first beginnings in history and perhaps the one which comes most readily to one's mind in thinking of democracy is the Magna Charta.

The most significant features of democracy have been the results which have flowed from democracy as developed under the English constitution, namely: Freedom of the people; development of education; administration whereby justice is swift and sure; purity and lack of corruption in our law courts and regard for private rights.

With all these things, why the cause for the outcry to-day against existing conditions? The world war shook the world to its foundations and possibly it has been good for all of us to be shaken out of self-complacency and satisfaction. We are forced to the admission that if there have been beneficial growths as democracy has developed there have also been growths of a virulent and undesirable type. Who is to blame for this condition and how could undesirable conditions originate when so much that is desirable has been brought to pass?

The speaker believed that the solution of our present day difficulties will be solved not by revolutions nor any new-fangled schemes, but by finding out what is wrong with our systems and the why and the wherefore of our having gone astray.

Democracy, like any other form of government, involves primarily the relationship between the state and the individual and the question whether the individual is to be left full freedom to develop his life, as he will, subject to respect for the rights of others, or to have it ordered for him by the regimentation of some arbitrary power exerting authority in the name of the state.

To defend the liberties we prize against encroachment demands perpetual vigilance, and nothing can so much stimulate it as the spectacle of other countries where liberty as we know it has disappeared.

A hearty vote of thanks was given to the three speakers by the chairman of the Branch, G. P. F. Boese, A.M.E.I.C.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
Alan B. Dove, Jr.E.I.C., Branch News Editor.

The Hamilton Branch of The Institute met in the Science Hall, McMaster University, on the evening of Tuesday, February 19th, 1935. W. Hollingworth, M.E.I.C., chairman of the Branch, occupied the chair. After preliminary remarks, W. J. W. Reid, A.M.E.I.C., was called on to introduce the speaker of the evening, Mr. Balmer Neilly, B.A. Sc., C.E., one of Ontario's best known consulting mining engineers and one fully qualified to deal with the subject of "Mines and Miners."

Mines and Miners

Mr. Neilly stated that all the facts of mining were not evident from the information given by the promoters of mining stock; the difficulties were not mentioned, and the good points, if not absolutely magnified, greatly predominate. Since 1903, charters have been issued by the provincial government to forty-three hundred mining concerns, of which only forty-two have reached that stage of development which requires payment of government tax. Again, only one in three hundred is able to pay taxes, return of capital and hazard investment and actually reach the stage of being a successful mine.

The speaker expressed the opinion that mining was destined to assume the place in economic importance formerly held by our agricultural resources, in opening up new areas and attracting colonial settlers.

The value of the products of Canadian mines for 1934 was 278 millions. This showed an increase, of 26 per cent over 1933, and 25 per cent over 1929, the previous peak year.

Canadian mines employ over twenty-two thousand men in the mines and about one thousand prospectors. The mines are operated on three shifts of eight hours each. The miner works a six day week, but there is always a call for extra men, and many work the seven days. The average pay for the miner is $5.10 per shift.

Contrary to popular opinion, the foreign element does not predominate in the mining industry. Statistics show the following percentages, British stock 64 per cent, Italian 7.6 per cent, Slavs 7.2 per cent, Finns 4.2 per cent, Poles 2.9 per cent, and others 14.1 per cent, and it is interesting to note that of the 36 per cent classed as foreigners, 80 to 85 per cent of them are naturalized Canadian citizens, and in the second or third generation their children do not differ from Canadian boys and girls.

The advantages of a mining advance are manifold and include colonization, railway extension, development of water power and sales of the city products. Of the total value realized for the gold of Canada, one third goes to compensate labour, one third for supplies and equipment, and the rest to capital and funds. The cost of supplies with their attendant value to cities like Hamilton may be imagined when it is realized that every ton of ore ground necessitates about 4½ lbs. of steel in the form of balls for the grinder.

Mining taxes must be very carefully considered, for if the tax is raised then much ore must be left undeveloped. Government taxes here amount to $1.26 per ton of ore mined and reduced, and the cost of production is $4.16 including the tax.

In order to give an insight into the conditions met with in mines and the methods employed in obtaining the ore, Mr. Neilly showed two Ontario government films of the workings of the Hollinger Gold Mines at Timmins, Ont.

R. M. Dilly, of the Babcock-Wilcox & Goldie-McCulloch Engineering Society, Galt, brought greetings from his society and an invitation to attend their meeting Friday night. He proposed a vote of thanks to the lecturer for his splendid address. This was endorsed by all present.

Announcements were made and Mr. Milne was thanked for his services with the projector. The meeting then adjourned and refreshments were enjoyed in an adjoining room.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
J. E. Hawkins, S.E.I.C., Branch News Editor.

The Lethbridge Branch of The Engineering Institute of Canada held its regular meeting in the Marquis hotel on Saturday evening, February 2nd, 1935, with C. S. Donaldson, A.M.E.I.C., in the chair, and about forty-five members present.

The Production of Rubber

An interesting film kindly loaned by the Dominion Rubber Company on the production of rubber was shown. This dealt with the company's rubber plantations in the island of Sumatra, showing the initial work of clearing the jungle, planting, and grafting of the young trees and the tapping of the trees to obtain the sap or "latex" as it is called. The factory operations for converting the latex to rubber were then shown; the Hopkinson spray process being clearly explained by means of an animated drawing. Of particular interest was the fact that almost all the labour was done manually, due no doubt to the cheapness of native labour.

Century of Progress

Through the courtesy of the Ford Company and the Ford Motor Sales of this city, an interesting film dealing with the "Century of Progress" World's Fair at Chicago, and a trip through the Ford building was shown.

Concrete Highway Construction

Following this, a film on "Modern Concrete Highway Construction," furnished by the Canada Cement Company, was shown. The quarrying, washing, and screening of the coarse aggregate was first dealt with. Then came the weighing of the proper proportions of the coarse aggregate, the fine aggregate, and the cement, and the transportation to the mixers. The mixers performed the work of mixing and laying of the surface. The method of properly allowing the concrete to "set" and dry and the provisions made for expansion joints were shown. Finally the government supervision and testing work was outlined.

The meeting was followed by a buffet luncheon, which concluded a very interesting evening's entertainment.

The Lethbridge Branch of The Institute held its regular meeting in the Marquis hotel on Saturday evening, March 2nd, 1935, with C. S. Donaldson, A.M.E.I.C., in the chair.

Dinner was served to about thirty members. During the dinner Mr. and Mrs. George Brown and orchestra entertained the members with several very delightful numbers. Following the dinner community singing interspersed with vocal solos was enjoyed. Mr. Donaldson called upon W. L. McKenzie, A.M.E.I.C., the incoming chairman, to say a few words. Mr. McKenzie traced the growth of the electrical industry in the past forty years, concluding by mentioning some of the ideas held at that time which are entirely disregarded to-day.

Mr. Donaldson then introduced Mr. W. Pratt of the Otis-Fensom Elevator Company, and two excellent films supplied by that company were shown, the first dealing with the construction of the Empire State building and the second with the construction of the George Washington bridge.

The film dealing with the construction of the Empire State building traced the construction through from the fabrication of the columns in the Carnegie Steel Company's plants to their final assembly in the building. There are sixty-seven elevators in the building; the main elevators travelling to the eightieth floor where a transfer is made to the eighty-sixth floor, and finally one elevator travels to the observation tower, equivalent to the one hundred and second floor, 1,212 feet above street level. The whole building is 1,250 feet high.

The next film dealt with the construction of the George Washington bridge across the Hudson river, New York. This is a suspension bridge, being suspended from four cables, each 36 inches in diameter, which in turn are fastened to two towers 600 feet high, and anchored in bedrock at each side of the river. A very clear illustration of the spinning of the cables was given. The wire used in the cables totals a length of 107,000 miles or more than four times around the earth.

On behalf of the meeting Wm. Meldrum, A.M.E.I.C., moved a hearty vote of thanks to Mr. Pratt and the Otis-Fensom Company for their courtesy in connection with these films.

The meeting then adjourned to the mezzanine floor for a short business meeting, during which the result of the election of officers was announced.

Mr. Rudd spoke briefly on the work of the League of Nation's Society. The annual report was presented and passed. The report of the Programme committee was presented by Mr. Meldrum, and after a short discussion of the programme for the next season the meeting adjourned.

London Branch

S. G. Johre, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting of the London Branch of The Institute was held on February 20th, 1935, in the City Hall auditorium, the speaker being Mr. C. E. Simpson, of the All-Weld Company of Toronto, and his subject "Spray Metallizing."

In the absence of S. W. Archibald, A.M.E.I.C., chairman of the Branch, J. Ferguson, A.M.E.I.C., vice-chairman, presided.

Spray Metallizing

The speaker told how by ingenious methods cold metal can be taken into a spray gun in the form of wire, and instantaneously sprayed onto another metal surface like paint and done economically. The idea itself was not new, it was used extensively during the World War in somewhat the same way.

With the use of motion pictures, Mr. Simpson illustrated his address, showing graphically how the gun works making use of any metal that can be drawn into wire. Zinc, tin, copper, lead, iron, even stainless steel is now sprayed on. For instance it was possible now to spray the inside of water tanks to prevent rust, and the speaker went on to outline innumerable uses for the gun. It is a cold process, one's hand could be put right through the spray and come out metal plated but not burned. The metal wire is melted just as it leaves the gun, with the use of oxy-acetylene, and is made permanent on the surface by impact.

The process was particularly useful to engineers, contractors and manufacturers, as well as electrical workers. Mr. Simpson said, showing how worn parts, shafts particularly, can be built up to their original size and shape, thus saving the cost of new parts, or in some cases the possible scrapping of the machine.

Moncton Branch

V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.

Methods of coal testing employed by the Canadian National Railways formed the subject of a very instructive paper read before a regular meeting of the Branch on January 29th, 1935, by David Hourston, Branch Affiliate. J. G. Mackinnon, M.E.I.C., chairman of the Branch, presided.

Coal Tests

Inasmuch as ten cents of every revenue dollar is spent by the railways for fuel, the importance of fuel tests cannot be overestimated. Laboratory tests are useful as a check but locomotive running tests are required to take care of all the factors entering into the steaming value of any given grade of coal.

The run should be over a subdivision of from seventy-five to one hundred miles long, where at least a three hour run may be expected. The physical characteristics of the subdivision chosen should be such that the engine will have to be worked most of the time and where very little drifting and braking will be encountered due to down grades. The class of train essential to bring out the best results will be one with full tonnage on a run with very little detention. The conditions under which each test is made should of course be as nearly identical as possible.

The speaker described, at length, the test instruments attached to the locomotive and the readings taken.

A vote of thanks to Mr. Hourston was moved by T. H. Dickson, A.M.E.I.C., seconded by R. H. Emmerson, A.M.E.I.C.

Modern Arc Welding

On February 19th David Boyd, B.Sc., A.M.E.I.C., of the Dominion Bridge Co. Ltd., Montreal, delivered an illustrated address on "Modern Arc Welding." J. G. Mackinnon, A.M.E.I.C., was in the chair.

Mr. Boyd described the materials and types of electrodes used in welding. With the aid of slides he showed illustrations of correct design and also the more common errors in the design of welded connections. A brief description was given of the annealing process for reducing internal stresses. In the opinion of the speaker, at least one year is required to train a welder. An inspector should not only be a welder but a qualified engineer as well.

In answer to questions, Mr. Boyd stated that in buying a welding machine, he would suggest a capacity of at least 300 amperes and a potential at the electrode of not less than 40 volts.

The welding of locomotive boilers was not yet permitted but when it is, the speaker was of the opinion that boiler pressures could be doubled and the steam locomotive compete to better advantage with the oil electric.

The electric arc is not suitable for welding rail ends. The thermit process is the one found most satisfactory.

A vote of thanks to Mr. Boyd was moved by C. S. G. Rogers, A.M.E.I.C., seconded by H. J. Crudge, A.M.E.I.C.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Mechanical Section—Arc Welding

On February 4th, 1935, David Boyd, A.M.E.I.C., further developed his paper as given on the Thursday evening previous, illustrating his talk with slides and models.

H. J. Roast, M.E.I.C., was again in the chair.

Economics and Design of Air Compressors

The history, design, economics and types of air compressors were described on the evening of February 7th, 1935, by F. G. Ferrabee, sales manager of the Canadian Ingersoll Rand Company Ltd., in a talk before the members of the Branch. The variety of uses for compressors were commented upon and examples given.

R. H. Findlay, M.E.I.C., presided.

Junior Section

On February 11th, 1935, two papers were presented before the Section: One by W. L. Thompson, Jr.E.I.C., engineer with the Bailey Meter Company, on "Flow Meters," and another by J. Royer, S.E.I.C., a student at McGill University, on the "Treatment of Copper Ores at Noranda."

Paul Vincent, S.E.I.C., was in the chair.

Broadcast Network of Canadian Radio Commission

Lieut.-Colonel W. A. Steel, M.C., Commissioner of Canadian Radio Commission, on February 14th, 1935, spoke on the broadcast network in Canada. He explained the complex networks used by the Commission to send out its programmes and the many technical problems involved in broadcasting. Some comparisons were made with British, European and American procedures, the speaker stating that due to the uneven distribution of the Canadian population the problems arising from broadcasting coverage were much more complicated in Canada than in most other countries.

H. J. Vennes, A.M.E.I.C., acted as chairman, and previous to the meeting an informal dinner was held at the Windsor hotel.

Lightning

On February 21st, 1935, Mr. A. C. Monteith, engineer with the Westinghouse Electric and Manufacturing Company, Pittsburgh, presented a paper on lightning problems, reviewing the present knowledge of natural lightning and factors to be considered in the design of transmission lines and substations. His address was illustrated by a number of excellent lantern slides.

Previous to the lecture an informal dinner was held at the Windsor hotel. Professor C. V. Christie, M.E.I.C., was chairman of the meeting.

Student Night

Two members of the Junior Section of the Montreal Branch presented papers at the meeting held on Thursday, February 28th, 1935.

Horace Young, a student in fourth year mining at McGill University, spoke on "Mineral Production in Canada and Effect in Industry," and Yvon Tasse, S.E.I.C., in his first year at the Ecole Polytechnique, who spoke in French, his subject being "Le Vent pour Electrifier nos Campagnes."

Recent Developments in Sound Pictures

S. T. Fisher, Jr.E.I.C., engineer in the special products engineering department of the Northern Electric Company, gave an exceedingly interesting address and demonstration on March 7th, 1935. He outlined the history, thecry and practice of sound reproduction as applied to moving picture theatres and to public address systems. Recent improvements have been mainly in three ways: the successful transmission of low- and high-pitched voices and other sounds, by improvements in the volume of sound and by reduction in the noises created by the reproducing mechanism.

J. L. Clarke, M.E.I.C., presided.

Junior Section

On Monday, March 11th, 1935, papers were presented before this section on "Technical Advance in Russia," by E. I. Wigdor, S.E.I.C., and "Air Conditioning for Comfort and Industrial Purposes," by Andre Michaud, S.E.I.C.

Mr. Wigdor is in his final year in electrical engineering at McGill University, and Mr. Michaud was a graduate in 1934 from the Ecole Polytechnique.

W. S. Bowles, S.E.I.C., acted as chairman.

Air Conditioning in Industry

Mr. Walter L. Fleisher, consulting engineer, of New York, and editor of the "Guide" of the American Society of Heating and Ventilating Engineers, spoke to the members of the Branch on March 15th, 1935. He pointed out that the future of air conditioning in Canada, as distinguished from that in the United States, was a winter problem rather than a summer one, and consequently any equipment used should be designed with this in mind. Interesting data regarding air conditioning in general was furnished.

Brian R. Perry, A.M.E.I.C., occupied the chair, and previous to the meeting an informal dinner was held at the Windsor hotel.

Stainless Steel

On March 21st, 1935, C. M. Carmichael, general manager of the Shawinigan Stainless Steel and Alloys Limited, presented a paper on the history and application of stainless steel. This was discovered by accident at Sheffield, England, during experiments on gun linings and is now used extensively in many industries.

C. R. Whittemore, A.M.E.I.C., presided.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The Branch held a well attended dinner meeting at the King Edward hotel, Niagara Falls, on March 13th, 1935, at which Mr. David Boyd, assistant works manager of the Montreal fabricating shops of the Dominion Bridge Company, spoke on the art of "Arc Welding."

Arc Welding

"Although welding has been practised from time immemorial," said Mr. Boyd, "it is only within the last fifty years that the development of electricity and the improved science of metallurgy has allowed its use to be extended to the field erection of bridges, ships, buildings and to the shop welding of huge members used in various engineering designs, some of which weigh ten tons and over.

"Most of the metals and alloys can now be successfully welded with joints that are practically unnoticeable and being as strong, or stronger than the original metal. At least one half of the test bars will break outside of the weld.

"Metallic arc welding is being used more and more for the fabrication of gear wheels, machinery frames and bases, column footings and other shapes which, until a few years ago, were made entirely of cast iron or steel.

"In structural steelwork, welding has not altogether taken the place of rivets, principally on account of the difficulty in making tests of work which has been field connected. Many of the principal joints are therefore riveted whereas the secondary connections may be welded."

Lantern slides were shown of the new Caughnawaga and Isle d'Orleans bridges, in the construction of which welding was employed extensively. Another novel use was the fabrication and erection of the light reinforcing steelwork for an eleven-storey concrete building: the metal work being entirely completed before any concrete was poured thus saving much of the supports for formwork and allowing the allied trades to instal the necessary pipes and electric wiring conduits.

After a vote of thanks to the speaker had been tendered by chairman W. R. Manock, A.M.E.I.C., the amount of local interest was shown by a discussion which lasted until nearly midnight.

Mr. Boyd has addressed several of our Branches during the past winter and is preparing an article on the subject of welding which will appear in The Journal.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

THE PRESENT STATUS OF TIDAL POWER

At the first noon luncheon of the 1935-1936 year, held at the Chateau Laurier on February 21st, 1935, H. E. M. Kensit, M.E.I.C., M.A.I.E.E., spoke upon "The Present Status of Tidal Power." Dr. R. W. Boyle, M.E.I.C., chairman of the Ottawa Branch, presided, and in addition head table guests included: J. L. Busfield, M.E.I.C., of Montreal; Hon. T. G. Murphy, C. A. Magrath, M.E.I.C., Dr. A. E. Cameron, R. A. Gibson, Norman Marr, M.E.I.C., Prof. A. S. Cudmore, G. S. Wrong, J. A. Rodd, J. L. Stiver, L. S. McLaine, and Victor Meek, M.E.I.C.

Tidal power utilization, Mr. Kensit stated, is not new. Probably the earliest tidal plant was the water-wheel installed by a Dutchman, Peter Morice, in one of the arches of London Bridge in 1582, to operate a pump for water supply—this was in use, with extensions, for over one hundred years. Other more recent examples of small installations have been in existence for many years in America. The question really is not so much can power from tidal sources be developed, as, is such development commercially practicable on a larger scale? At present both capital and production costs of tidal power appear to be slightly above the best obtainable from fuel or from possible available undeveloped water powers.

Also the technical aspect of tidal power production is more involved than is the case with the usual water power development.

Several types of tidal power development are possible: the single basin type, either unassisted or used in conjunction with other power stations; the single basin type supplemented, where possible, by elevated natural water storage to which water may be pumped by the surplus power at high tide, the combination furnishing continuous power; the single basin type supplemented by fuel auxiliary; and various forms of the multiple basin type that can be operated to give continuous power without either elevated storage or fuel auxiliary.

Large scale projects for the development of tidal power have been under investigation in various parts of the world: on the eastern coast of the Argentine; on the coast of Brittany; on Passamaquoddy bay and at the junction of the Petitcodiac and Memramcook rivers in Canada; and on the estuary of the Severn river between England and Wales.

Two of these that have received most thorough investigation are those on the Severn in England and on Passamaquoddy bay in Canada. The latter, in addition to examination and estimates by private interests, has been investigated by the Board of Engineers of the United States Army. This board estimated it could provide for an ultimate installation of 1,087,000 h.p. at a cost of $100,000,000 or $92 per horse power, which is a substantially lower figure than that so far estimated for any other large tidal power project.

Probably the controlling factor in holding back the development of large tidal power projects has been the advances that have been made in recent years in reducing both the capital and production costs of fuel power. The coal required for a given output, for instance, has been more than halved in the last fifteen years.

Peterborough Branch

H. R. Sills, Jr.E.I.C., Secretary.
E. J. Davies, Jr.E.I.C., Branch News Editor.

ARTIFICIAL ILLUMINATION AND ITS PART IN MODERN LIFE

The story of illumination was told to the members of the Peterborough Branch and their friends on February 21st, 1935, in the auditorium of the Peterborough Collegiate and Vocational School, and was presented by the Canadian General Electric Company, the Canadian Westinghouse Company and the Ontario Hydro-Electric Power Commission.

The first part of the programme was covered by a talking picture entitled "The Science of Seeing," featuring H. F. Barnes of the Nela Park laboratories of the General Electric Company. Lecturing from the screen, Mr. Barnes outlined the fundamentals in the relationship of illumination to healthy vision.

Four factors in regard to satisfactory illumination were urged. Rooms should first be illuminated with light of an intensity high enough to serve the specific needs. Whereas relatively dim light is satisfactory for stairways and hallways, very bright light is required for sewing and the reading of small types. Rooms should be lighted in such a way that little lighting contrast is permitted, and lighting systems should be such that glares are avoided, it was pointed out.

A practical demonstration on lighting was staged by Mr. G. F. Mudgett of the Westinghouse Company, in which he demonstrated different kinds of lights and the contrast between glaring and non-glaring lights. He showed that by covering a glaring light with a transparent shade that the glare was eliminated and yet the light intensity received by a meter was not diminished.

Mr. G. G. Cousins of the Hydro-Electric Power Commission spoke on the fundamental principles of illumination covering the light intensity required for different uses of the eye. He demonstrated the ideal student reading lamp, designed by the Illuminating Engineering Association to cover the requirements of students. The bottom of the shade of these lamps is at a distance of from 18 to 20 inches from the table. The light used is 100 watt, part of which is thrown directly to the ceiling and the balance through a transparent secondary shade to the table. Mr. Cousins made a special appeal to the parents on behalf of the boys and girls who have homework to do, and urged the parents to see that young people were supplied with suitable lighting in order to preserve their good health and their eyes.

An animated cartoon film urging the importance of modernized lighting systems in city streets rounded out the programme. Mr. R. Wilde of the Canadian General Electric Company officiated in the projection of the pictures, while Mr. Wm. Dickson assisted Mr. Mudgett with the series of slides depicting properly and improperly lighted rooms in homes. The meeting, under the chairmanship of Ross L. Dobbin, M.E.I.C., was attended by more than three hundred persons who thoroughly enjoyed the programme.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

SOME CONSIDERATIONS GOVERNING THE UNDERTAKING OF HYDRO-ELECTRIC POWER DEVELOPMENTS

"The author has endeavoured in this paper to give some idea of the problems to be encountered when any hydro-electric power development is under consideration. The science of hydro-electric power engineering has made great advances in recent years, but the difficulties to be surmounted become greater all the time. The engineering profession has also increased its knowledge and it is hard to conceive of any problem that will remain unsolved for long. Certainly things are being accomplished to-day that would have been mere pipe dreams a few years ago."

This was the conclusion of the paper presented by E. D. Gray-Donald, M.Sc., A.M.E.I.C., superintendent, Power Division, Quebec Power Company, at a luncheon meeting of the Quebec Branch held at the Chateau Frontenac on January 14th, 1935.

"In Canada the greater amount of power is developed by hydraulic means; the installed horse-power at the end of 1933 was 7,332,000 h.p., the output was estimated as the equivalent of 15 million tons of coal. In a country where the few available coal deposits are far from the centres of industry it is a very important factor."

The speaker said a few words on the trends in hydro-electric power development and briefly described the Boulder Dam project on the Colorado river.

"The popular belief that electricity generated by means of water power is always cheaper than that generated in steam plants, is a fallacy. The reason for this is the tremendous capital cost of hydraulic works, the cost of storage water as an operating charge, and the long distances over which hydro-electric power usually has to be transmitted, involving high investment in transmission lines and continuous loss of power. Except in special cases careful analysis must be made to find which is the more economical method of generation."

"In any undertaking for the supply of electric power there are a great many factors to be considered, the two fundamentals of which are demand for power and available source of water supply."

The speaker mentioned the manufacture of newsprint paper as one of the greatest industries using electricity in eastern Canada and gave some information in this connection; he then gave valuable information in regard to the projects under construction or to be executed in the future on the St. Maurice river.

The question of water supply was fully dealt with and geological considerations were mentioned as a very important factor governing the location of a dam.

The last paragraph of Mr. Gray-Donald's lecture was dealing with the construction organization and the line of communication with the construction force.

LA ROUTE MODERNE

Tel fut le sujet d'une très intéressante causerie qui fut donnée à un déjeuner de notre section, le 18 mars, 1935, par M. Alphonse Paradis, Ingénieur en Chef au Ministère de la Voirie de la Province de Québec.

Le conférencier fut présenté à l'auditoire par M. Hector Cimon, M.E.I.C., président de la section, puis M. L. P. Méthé, A.M.E.I.C., Directeur de l'Ecole Technique de Québec, proposa un vote de remerciements chaleureusement secondé par les applaudissements.

Nous croyons que la causerie de M. Paradis sera publiée prochainement dans ce "Journal".

Sault Ste. Marie Branch

H. O. Brown, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Sault Ste. Marie Branch was held at the Windsor hotel on Friday evening, February 22nd, 1935. The usual form of dinner meeting was followed, and about sixteen sat down to the dinner preceding the business meeting.

F. Smallwood, M.E.I.C., the chairman, presided, and the regular business meeting was held at the close of the dinner. The members of the Branch were interested in the "Proposed Consolidation of the Engineering Profession in Canada" as referred to in the resolution of the Montreal Branch presented at the annual meeting held in Toronto, and also the resolutions passed at the Toronto meeting.

The Branch asked that the Executive review the correspondence and proposals received and be prepared to present a resolution to the Branch at a later meeting.

The speaker of the evening, Mr. James Kelleher, of the Fitzgerald Laboratories, was introduced by H. F. Bennett, A.M.E.I.C., and the subject of his address was "Research Work in the Ceramic Industry."

Research Work in the Ceramic Industry

The speaker pointed out that the ceramic industry covered a very large field when defined as the art of making pottery, china and porcelain wares. As it may be naturally divided into coarse products such as brick, tile and terra-cotta, and fine products as chinaware and porcelains, the paper was confined to the fine products.

An outline of the origin of the clays, the preparation of the clays, the moulding of the various types of articles, the firing or baking, the decorating and glazing were all described very fully by Mr. Kelleher and illustrated with large diagrams.

The special research work carried out at the Fitzgerald Laboratories a few years ago and with which Mr. Kelleher was associated was principally in connection with the porcelains for spark plugs for motor cars.

A special electric furnace was developed for the research work and the various problems met with such as irregular baking and shrinkage and "blistering" were finally overcome. The final results attained were a more durable product, a greatly reduced manufacturing time and shrinkages controlled within the limits allowed.

Reference was also made to some research work carried on in the baking of "abrasive" wheels in the electric furnace and also other articles which presented difficulties in the ordinary gas or oil-fired furnaces.

The meeting was thrown open for questions at the close of the paper and the subject proved to be of great interest to all the members present.

A very hearty vote of thanks was extended to Mr. Kelleher by the members of the Branch for the presentation of his paper.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Annual Supper Dance

In no small way were the Winnipeg Branch of The Institute together with the Association of Professional Engineers of Manitoba successful with their ninth annual supper dance, held in the Royal Alexandra hotel on the evening of February 21st, 1935.

The main dining room was most effectively decorated for the occasion. The entire ceiling was draped with gold, scarlet and blue. From a setting in silver stars a golden moon shone down upon a Venetian scene, while the orchestra in a scarlet and gold gondola supplied the latest dance music for a capacity gathering of carefree engineers, their wives and friends. Lantern lights from gay gondola pontoons and coloured tapers lit up the flower-decked supper tables.

S. E. McColl, A.M.E.I.C., and his committee are to be highly complimented on their efforts, which truly warranted the successful evening.

Report of Annual Meeting

The annual meeting of the Winnipeg Branch of The Institute was held at the University of Manitoba on Thursday, February 7th, 1935, at 8.40 o'clock p.m. Major A. J. Taunton, A.M.E.I.C., occupied the chair.

The minutes of the previous meeting were read by the Secretary and adopted. The chairman reported that as the proposals for the joint Executive Control of the Branch and of the Association of Professional Engineers of Manitoba had not become effective, the amendments to the By-laws of the Branch were unnecessary, and that amendments affecting the method of securing the consent of nominees for candidature at elections were being considered by F. G. Goodspeed, M.E.I.C.

The chairmen of the following committees read their reports: Joint Committee on Unemployment, Professor J. N. Finlayson, M.E.I.C.; Library and Publication, J. F. Cunningham, A.M.E.I.C.; Programme Committee, G. E. Cole, A.M.E.I.C. The Secretary read the report of the auditors, Messrs. J. C. Trueman, A.M.E.I.C., and Alex Campbell, A.M.E.I.C., and that of the scrutineers, Messrs. G. Affleck, A.M.E.I.C., and F. E. Umphrey, A.M.E.I.C.

The following chairmen of committees were elected: Advisory Committee, E. W. M. James, A.M.E.I.C.; Library and Publications Committee, L. M. Hovey, A.M.E.I.C.; Programme Committee, W. D. Hurst, S.E.I.C.; Research and Investigation Committee, F. G. Goodspeed, M.E.I.C.; Branch representative on The Institute Nominating Committee, A. J. Taunton, A.M.E.I.C. Auditors, G. M. Pearston, A.M.E.I.C., and J. T. Rose, A.M.E.I.C.

The retiring chairman then made his address, after which he announced that the secretary, Mr. E. W. M. James, was also retiring, and made very appreciative remarks in connection with Mr. James' long term of office.

The incoming chairman then took the chair and introduced the speaker, Professor Wardle, professor of zoology of the University of Manitoba, who gave a "New Discourse on a Stale Topic," in which he dealt with the place of the imagination in scientific observations, particularly in the field of mediæval pharmacy, zoology and medicine and surgery.

Professor G. H. Herriot, M.E.I.C., moved a vote of thanks to the speaker and the meeting adjourned at 11 o'clock p.m., after which refreshments were served.

Explosives in Peaceful Pursuits

A good audience of engineers made their way through Winnipeg's record fall of snow to hear Mr. J. S. Morrey, Explosives Division, Canadian Industries Limited, present a paper entitled "Explosives in Peaceful Pursuits" on March 7th last.

Mr. Morrey defined an explosive as a substance which by the application of friction, heat, spark, or shock would instantly be converted into an enormous volume of gas.

Liquid and highly dangerous nitroglycerin was made comparatively safe by Alfred Nobel, by dissolving gun cotton in it, thereby producing gelatinized dynamite. The new product opened the gateway to the commercial use of high explosives.

When explosed, the first dynamites gave off large quantities of poisonous gases. Today, dynamites can be obtained which include ingredients which make the gas products almost entirely harmless.

The percentage of a dynamite means the percentage strength of the dynamite, compared with pure nitroglycerin. The speed of explosion of a dynamite is known as its velocity of detonation, and is as high as 12,800 feet per second.

Black powder is a mixture of charcoal 16 per cent, sulphur 11 per cent, and saltpetre 73 per cent. It is used chiefly in coal mines for its 'heaving' action, where a fast explosive would shatter the coal.

In mines where gas is met with, a 'permitted' explosive is used. This is a low grade dynamite, which because of its reduced burning time as compared with black powder, minimizes the possibility of the explosion igniting the mine gas.

The hour of questions and discussion which followed the presentation of Mr. Morrey's paper showed the general interest in the subject. A hearty vote of thanks was tendered the speaker, after which those present enjoyed light refreshments and a social half hour.

Association of Professional Engineers of Saskatchewan

The fifth annual meeting of the Association of Professional Engineers of Saskatchewan, was held at the Hotel Saskatchewan, Regina, on February 15th, 1935. The afternoon was taken up with a Council meeting and the general meeting of the Association, at which general business was transacted.

At this meeting, Mr. D. A. R. McCannel, M.E.I.C., chairman of the committee for co-ordinating the activities of engineering organizations in the province, presented a report which contained the following recommendations which were adopted by the meeting:

(1) That the Professional Association in Annual Meeting to-day approve the following resolution—"resolved that the Association of Professional Engineers of Saskatchewan in Annual General Meeting assembled hereby goes on record as being in favour of the consolidation of the engineering profession in Canada.

(2) That the Council of the Association and the Saskatchewan Branch, Engineering Institute of Canada, give early consideration to the appointment of a joint Secretary, preferably a member of both societies, who is in private practice.

(3) That the Association of Professional Engineers of Saskatchewan arrange annually for a general meeting of all Saskatchewan engineers to consider and promote the interests of the engineering profession and of the province.

(4) That the Council of the Association of Professional Engineers endeavour insofar as possible, to arrange for its Council meetings at a date that will coincide with meetings of engineering societies in Regina.

The result of the ballot for election of officers was as follows: President, H. C. Ritchie, A.M.E.I.C.; vice-president, D. A. R. McCannel, M.E.I.C.; Councillors, H. Forbes-Roberts, S. T. Lewis, A. P. Linton, A.M.E.I.C. These, with the following, who remain in office for one year constitute the new executive. Those remaining in the Council: H. R. MacKenzie, A.M.E.I.C., W. W. Perrie, A.M.E.I.C., J. J. White, A.M.E.I.C., and Professor W. E. Lovell, A.M.E.I.C. And one member from the faculty of the University to be appointed by the Lieutenant-Governor-in-Council.

An audited financial statement presented showed cash on hand of $702.62 and a Dominion Government 5 per cent bond for $1,000.

The evening was given up to a banquet presided over by the new president, Mr. Ritchie, and musical and other entertainment was provided by the entertainment committee.

Preliminary Notice

of Applications for Admission and for Transfer

March 23rd, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in May, 1935.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some hranch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not alresdy passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

BOWEN—HENRY BLAKE, of 3018 Breslay Road, Montreal, Que., Born at Chapel-en-le-Frith, Derbyshire, England; Educ., 1903-05, Manchester School of Technology: 1900-03, Crossley Bros., Manchester, England: With the C.P.R. as follows: 1905-06, special ap'tice, Angus Shops; 1906-07, dftsman., Winnipeg; 1908, foreman, loco. shops, Winnipeg; 1909-11, shop engr., Winnipeg; 1911-19, chief dftsman., Winnipeg; 1920-27, works manager, Winnipeg shops; 1928, asst. supt., motive power, and 1928 to date, chief of motive power and rolling stock.
References: W. F. Angus, D. E. Blair, W. F. Drysdale, J. M. R. Fairbairn, P. B. Motley, J. A. Shaw, E. J. Turley, H. H. Vaughan.

BUCK—LESLIE GORDON, of Lachine, Que., Born at Brantford, Ont., July 8th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1925; With the Bell Telephone Company of Canada as follows: 1924-25, student engr., Toronto; 1925-27, field engr., Toronto Divn.; 1927-29, dist. plant engr., Toronto Divn.; 1929-30, asst. to exchange plant engr., gen. engrg. dept., Montreal; 1930-34, exchange plant engr., eastern area, Montreal; 1934 to date, divn. plant engr., Montreal Divn.
References: A. M. Reid, A. M. Mackenzie, G. E. Templeman, J. L. Clarke, J. G. Caron, R. W. Bastable, S. G. Naish, T. C. Thompson.

DE MIFFONIS—LOUIS FERNAND HENRI, of Ottawa, Ont., Born at Paris, France, May 24th, 1882; Educ., B.Sc., Univ. of Paris, 1900. Two years special course maths. and physics; 1905, supervising constrn. work for Pepin & Cie., Ottawa; With Dept. of Marine, Ottawa, as follows: dftsman.; 1907-10, design of aids to navigation, more particularly concrete structures, and field supervising; 1911-23, in charge of design and improvement of lighthouse apparatus; research work in connection with same; supervision of their manufacture at the Dominion Lighthouse Depot; 1924-28, in charge of Dominion Lighthouse Depot. (Manufacture of aids to navigation for all Candn. Lighthouse Service); 1929-32, acting asst. chief engr., and 1933 to date, acting chief engr. of Dept. of Marine.
References: J. L. Busfield, J. A. E. Gohier, J. G. Macphail, F. Anderson, C. P. Edwards, K. M. Cameron, R. deB. Corriveau.

FYSHE—THOMAS MAXWELL, of Montreal, Que., Born at Halifax, N.S., Sept. 7th, 1883; Educ., B.Sc. (Civil), McGill Univ., 1905; 1901, Geol. Survey, Canada; 1902, General Electric shops, Schenectady; 1903, rodman, C.P.R., Regina; 1904, transitman, C.P.R., Vancouver; 1905-06, asst. engr., Waddell & Hedrick, consltg. engrs., Kansas City, design and constrn.; 1906-07, asst. to R. S. Lea, M.E.I.C., Montreal, as designing engr., and salesman, Corrugated Steel Bar Co., Montreal; 1908-11, mgr., Walker-Fyshe Co., Montreal, engrs. and contractors. Operating Raymond Concrete Pile Co. and Ambursen Hydraulic Constrn. Co.; 1911-15, President, Fyshe-Martin Co., and Fyshe, McNeill Martin & Trainor Ltd., Calgary, engrs. and contractors. President, North West Drilling Co., Vice-President, Can. West. Nat. Gas, L.H. & P. Co., Calgary; 1916-19, mgr., and after first year, partner for Canada, Gunn, Richards & Co., engrs. and accountants, Montreal and New York; 1920-24, private practice, Montreal, Okla., Texas, Arkansas. Oil development and production, etc.; 1925-31, investigations and reports for financial firms, New York and Montreal; Bauer, Pond & Vivian, and H. D. Williams & Co., New York; Nesbitt Thomson & Co., and Power Corpn. of Canada, Montreal; 1932 to date, private practice, investigations and reports, mostly financial.
References: R. S. Lea, W. S. Lea, J. G. G. Kerry, J. B. Woodyatt, R. J. Durley, H. B. Muckleston, C. M. Morssen, C. N. Monsarrat.

GRATTON—ALPHONSE, of 84 St. Louis Road, Quebec, Que., Born at Ste. Therese, Que., March 30th, 1888; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1912; 1909-12, asst. to engrs., and 1912-15, asst. engr., Harbour Commission of Montreal; 1915-19, asst. engr., Montreal Water Level Commission, Dept. Marine and Fisheries; 1919-32, divn. engr., and 1932-35, dist. engr., Dept. of Roads, Prov. of Quebec, also 1925-35, professor of highway engrg., Ecole Polytechnique, Montreal.
References: F. W. Cowie, O. O. Lefebvre, A. Frigon, A. Duperron, J. P. Leclaire, J. A. Lalonde, A. B. Normandin.

GAUTHIER—JOSEPH EUGENE, of Gaspe, Que., Born at New Richmond, Que., Feb. 9th, 1907; Educ., 1921-23, St. Joseph's Univ., Memremcook, N.B. 1925-26, commercial course, Commercial Academy, Quebec, Que.; Three years in woods studying surveys, classification and measurement of lumber. Lumber scaler license obtained in 1925; I.C.S. Highway Engrg. Course. Private tuition; 1923-27, woods survey, classification, and measurements of lumber, Lincoln Mills, Pulpwood Company, and Bonaventure Pulp & Paper Co., Chandler; 1927-30, clerk in Roads Dept. office at Gaspe, and 1930 to date, asst. divnl. engr., Quebec Roads Dept. Work includes charge of municipal roads built by municipalities of Gaspe North and Gaspe South, charge of constrn. of Perron Blvd. Route No. 6, around Gaspe Peninsula, constrn. of wooden bridges, elimination of rld. crossings, Chandler, constrn. of permanent pavement in Chandler, upkeep and mtce. of highway in Gaspe South.
References: J. A. Lefebvre, J. N. T. Bertrand, J. A. Adam, J. A. L. Dansereau, J. H. Landry.

HERSHFIELD—CHARLES, of Toronto, Ont., Born at Winnipeg, Man., Dec. 24th, 1910; Educ., B.Sc. (Civil), Univ. of Man., 1930; 1928 (summer), and May 1929 to April 1930, dfting and estimating, Winnipeg office, and 1930 (May-Sept.), detailing of struct'l. steel and reinforced concrete, Dominion Bridge Company, Winnipeg; Sept. 1930 to May 1932, designing, dfting., detailing, engrs. dept., City of Winnipeg.
References: H. M. White, J. N. Finlayson, W. P. Brereton, A. E. MacDonald, J. C. Trueman.

LYMAN—CHARLES PHILIP, of 4155 Cote des Neiges Rd., Montreal, Que., Born at Westmount, Que., Aug. 25th, 1907; Educ., B.E., McGill Univ., 1933; Summers: 1925, rodman on constrn., Southern Canada Power Co.; 1926, instr'man. on location surveys, Shawinigan Engrg. Co.; 1928, instr'man., Can. Inter. Paper Co.; 1927 (Mar.-Sept.), instr'man., Fraser Brace Engrg. Co.; 1927 (Sept.-Nov.), instr'man., Montreal Engrg. Co.; 1928 (Jan.-Feb.), instr'man., Can. Inter. Paper Co.; 1928 (Mar.-Apr.), field engr. on transmission line constrn., Fraser Brace Engrg. Co.; Sept. 1929 to Jan. 1930, field engr. on trans. line constrn., and 1931 (Aug.-Nov.), chief of survey parties, St. Maurice River, Shawinigan Engrg. Co.; 1930 (Jan.-May), dftsman., J. M. Robertson, M.E.I.C.; 1934 (Jan.-Mar.), dftsman., R. O. Sweezey, M.E.I.C.; 1934 (Mar.-Nov.), field engr., supervn. of constrn., Sun Oil Co. Ltd.
References: J. A. H. Henderson, C. R. Lindsey, T. M. Montague, J. S. H. Wurtele, R. E. Heartz, J. Weir, E. Brown.

MACGILLIVRAY—MALCOLM STUART, of Montreal, Que., Born at Kingston, Ont., May 18th, 1901; Educ., B.Sc., Queen's Univ., 1923; 1923-25, engrg. ap'tice. course, Canadian Westinghouse Co. Ltd., Hamilton, Ont.; 1925-26, demonstrator, elec. engrg., Univ. of Toronto; 1926-29, asst. elect'l. supt., Aluminum Co. of Canada Ltd., Arvida, Que.; 1929 to date, with T. Pringle & Son, Ltd., consltg. engrs., Montreal, responsible for design and supervision of elect'l. and mech'l. equipment in numerous industrial plants; also investigations and reports on industrial engrg. and power problems.
References: J. S. Costigan, G. M. Wynn, J. M. Campbell, D. M. Jemmett, A. W. Whitaker, Jr., G. E. Templeman, A. C. Johnston.

NEWMAN—WILLIAM ARTHUR, of 488 Mount Pleasant Ave., Westmount, Que., Born at Hamilton, Ont., June 29th, 1889; Educ., B.Sc., Queen's Univ., 1911; 1908-9-10, various short term positions securing engrg. and constrn'l. experience during vacations; 1911-13, various positions at Angus shops and Smiths Falls roundhouse, C.P.R.; 1913-14, lecturer in maths., and 1914-16, asst. professor, mech'l. engrg., Queen's University; With the C.P.R., at Montreal as follows: 1916-17, supv. betterments; 1917-18, asst. mech. engr.; 1918-20, engr. of locomotive constrn.; 1920-23, engr. of locomotive and car constrn.; 1923-28, mech. engr., and 1928 to date, chief mech. engr.

References: J. M. R. Fairbairn, P. B. Motley, H. H. Vaughan, F. Newell, D. G. Anglin, R. J. Durley, D. E. Blair.

SPENCER—HENRY CYRIL, of 4321 Beaconsfield Ave., Montreal, Que., Born at Norwood, London, England, May 20th, 1896; I.C.S. Montreal Technical Institute, 2nd and 3rd year electro-technics; 1912 to date (except 1915-19, military service), with Northern Electric Company as follows: 1912-13, shops; 1913-14, planning dept.; 1919-25, mech'l. divn., tool design, dfting., and tool checking; 1925-29, tool estimating and in charge of automatic screw mach. tools and equipment; 1929 to date, in charge, design dept., screw mach. tools and equipment.

References: J. D. Hathaway, W. H. Eastlake, J. S. Cameron, S. R. McDougall, H. Miller.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

ARCHIBALD—SAMUEL WALLACE, of London, Ont., Born at Seaforth, Ont., May 13th, 1894; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1922. O.L.S., 1925. R.P.E. Ont.; 1916-18, overseas, Major, C.E.F.; 1919, chainman, and 1920, instr'man. on location, res. on constrn. rly. spur and transmission line, Nipissing district, with Lang & Ross, Ltd., Sault Ste. Marie, Ont.; 1921, instr'man., with H. J. Beatty, O.L.S., Pembroke, Ont.; 1922-23, instr'man. in charge of party, Sudbury district, with J. W. Fitzgerald, O.L.S., Peterborough; 1922-23, instructor in engrg. drawing and maths., Sault Ste. Marie Tech. School; 1923-24, demonstrator, dept. of drawing, Faculty of App. Sci., Univ. of Toronto; 1924, instr'man. in charge of party, highway location, Lake Superior east shore, with Lang & Ross, Ltd.; 1925 to date, in practice as consltg. engr. and surveyor, at Seaforth, Ont., and at London, Ont., and the following winter work: 1927, in charge of party, flooded area survey, Wicksteed and Martin lakes, for Lang & Ross, Ltd.; 1928, transitman, transmission line location, Algoma District, and 1928-29, in charge of party, transmission line location, Flin Flon, Man. to Island Falls, Sask., for same company; Consltg. work includes: surveys, awards and reports under the Drainage Acts of Ontario; topographic surveys, subdivisions, re-surveys, compiled plans, reinforced concrete design. (*A.M. 1928.*)

References: J. L. Lang, J. R. Cockburn, K. G. Ross, G. A. McCubbin, I. Leonard, R. E. Smythe, H. A. McKay.

BEACH—FLOYD KELLOGG, of 10957-90th Ave., Edmonton, Alta., Born at Hesperia, Mich., Dec. 30th, 1884; Educ., One year univ. work; Corres. School and private study. Admission to corporate membership E.I.C. by exam. 1913; D.L.S.; 1902, rodman, Mich. Cent. Ry.; 1906-09, transitman and dftsman. on D.L.S. work, irrigation surveys and rly. mtce.; 1910-13, private practice, highway, irrigation, rly. surveys, topographic mapping, etc.; 1913-16, irrigation and hydrometric surveys; 1916-19, overseas, Can. Rly. Troops, Lieut. Later Capt. and Major, 13th Field Co., Can. Engrs., Militia Staff Course; 1919-27, divnl. engr., hydrometric survey, and dist. engr. (irrigation); 1927 to date, petroleum and natural gas engr., Dept. of Lands and Mines of Alberta, Edmonton, Alta. (*St. 1910, A.M. 1913.*)

References: R. S. L. Wilson, G. N. Houston, S. G. Coultis, S. G. Porter, P. J. Jennings, P. M. Sauder, F. W. Alexander.

CORMIER—ERNEST, of Montreal, Que., Born at Montreal, Dec. 5th, 1885; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1906; 1906-08, struct'l. steel design, city office, Dominion Bridge Company, Montreal; 1915-18, with Considere, Pelnard, Caquot, Paris. Engr. in charge of concrete designs for French Govt.; 1925 to date, professor, Ecole Polytechnique, Montreal, and 1918 to date, private practice as architect and engr., reinforced concrete, heating, ventilation, refrigeration, elect'l. designs for churches, schools, public bldgs. and the Univ. of Montreal. (*St. 1904, A.M. 1909.*)

References: O. O. Lefebvre, G. M. Pitts, A. Frigon, A. D. Harrison, F. S. B. Heward.

FARRELL—JAMES WARDROPE DICK, of 3025 Rae St., Regina, Sask., Born at Smiths Falls, Ont., Sept. 20th, 1890; Educ., B.A., 1912, B.Sc., 1915, Queen's Univ.; 1913-14, asst. to dist. surveyor and engr., Dept. Highways, Regina; 1914-19, Can. Engrs., R.F.C., R.A.F., Overseas, Capt.; 1919, dftsman., dept. of irrigation, Calgary; 1920-24, asst. supt., and 1924 to date, supt. of waterworks, Regina, Sask., supervision and planning plant constrn. as well as charge of operation and mtce. (*Jr. 1920, A.M. 1921.*)

References: L. A. Thornton, D. A. R. McCannel, H. S. Carpenter, C. J. Mackenzie, A. C. Garner.

LAFLECHE—ALPHONSE, of Ottawa, Ont., Born at St. Martin, Que., Dec. 5th, 1884; Educ., Civil Engr., Ecole Polytechnique of Montreal, 1909; 1909-11, city engrg., Montreal; With Dept. of Marine as follows: 1911-17, junior engr., 1917-25, asst. engr., 1925-29, senior asst. engr., 1929 to date, asst. chief engr., River St. Lawrence Ship Channel. (*St. 1909, A.M. 1916.*)

References: N. B. McLean, F. Anderson, J. A. L. Dansereau, D. W. McLachlan, J. P. Leclaire, J. A. Smith.

MOTT—HAROLD EDGAR, of Brantford, Ont., Born at Winnipeg, Man., Dec. 4th, 1897; Educ., B.Sc., McGill Univ., 1922; With Canadian Marconi Co., Montreal, as follows: 1922, test engr.; 1923, engr. in charge, test dept.; 1923, supt. of works; 1924-27, works engr.; 1927-28, chief engr., De Forest Crosley Radio; 1928-33, mgr. of engrg. and production, and chief engr., Rogers Majestic Corpn.; 1933-34, consltg. engr.; 1934 to date, president and gen. mgr., H. E. Mott Co. Ltd., Brantford, Ont., designers and manufacturers of industrial equipment, etc. (*St. 1919, A.M. 1926.*)

References: C. V. Christie, J. H. Thompson, G. A. Lindsay, J. F. Plow, W. S. Stewart.

YOUNG—STEWART, of 2822 Rae St., Regina, Sask., Born at Owen Sound, Ont., Sept. 2nd, 1884; Educ., Diploma, S.P.S., 1911, B.A.Sc., 1912, Univ. of Toronto. D.L.S. and S.L.S. 1913. Summers: 1910, inspr., waterworks and sewers, Cobalt; 1911, dftsman., G.T.P., Winnipeg; 1912, triangulation surveys, B.C.; 1912-13, checking plans, asst. surveyor, Dept. Public Works, Sask.; With the Province of Saskatchewan as follows: 1913-16, misc. surveyor; 1916-17, acting district surveyor; 1917-24, district surveyor; 1924, res. engr.; 1924 to date, director of town planning (*A.M. 1917.*)

References: H. S. Carpenter, H. R. MacKenzie, D. A. R. McCannel, A. P. Linton, J. J. White.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CHANDLER—EDWARD SAYRE, of Charlottetown, P.E.I., Born at Charlottetown, July 17th, 1901; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1931; 1917-19, meter reader, and 1925-30 (during vacations), supt.'s asst., Maritime Electric Co.; 1931-32, acting supt., Wolfville Electric Commn.; 1932 to date, Provincial Electrical Inspector, Charlottetown, P.E.I. (*St. 1930, Jr. 1932.*)

References: F. R. Faulkner, H. F. Laurence, H. E. Miller, H. W. McKiel, W. A. McLaren.

FOR TRANSFER FROM THE CLASS OF STUDENT

LAWRENCE—EDWARD ARTHUR, of Lethbridge, Alta., Born at Sydenham, London, England, July 5th, 1909; Educ., Junior Matric., Univ. of Alta., 1927; prep. course, struct'l. engrg., Wilson Engineering Corporation, Cambridge, Mass.; 1927 to date, with the C.P.R., Dept. of Natural Resources, Irrigation Branch, Lethbridge, Alta. Hydrometric work, misc. surveys, including gen. field, topog'l. and compass surveys; classification of land for irrigable area, cross-sectioning and profiles. Prelim. and final survey of new canal extensions. Instrument and office work in connection with building of earthwork dam for storage purposes. Office work in connection with above, also calculations for yardage and estimates. Dfting in connection with irrigation works. Present position, instr'man and hydrographer. (*St. 1932.*)

References: G. N. Houston, G. S. Brown, J. T. Watson, W. Meldrum, J. B. deHart.

FOR TRANSFER FROM THE CLASS OF AFFILIATE

SAMUEL—MYRON, of Toronto, Ont., Born at Libau, Latvia, Nov. 8th, 1898. (British Subject since 1932.) Educ., Engrg. Diploma, Engrg. College of Danzig, 1924. Member, V.D.I., 1931; 1919-20, ap'ticeship, Matisons Machine Works, Libau, and Danziger Shipbldg. and Engrg. Co.; 1923 (Apr.-Aug.), Sawmill and Lumber Transport and Shipping Co., Danzig, consltg. work in connection with new additions, preparing plans and estimates, testing and appraising of equipment; 1926-27, S. Behr & Mathew, Shanghai, China. Cold storage, refrigerated ships and produce packing. In charge of frozen egg mixing, filling and freezing plant and tin-box factory. Supervision of operations, time studies, lab. testing work, modernization of operations and plans for new installns.; 1927-32, J. I. Bernitz, Inc., New York and Toronto. Engrg. Sales and Service. Canadian representative in charge of preparing plans and estimates for additions to existing plants and new installns., installn. of equipment, acceptance tests, estimating cost of necessary repairs and directing the reconditioning of equipment, advising on engrg. problems. Making plans and designs for special purpose equipment, investigating breakdowns; April 1932 to date, proprietor of the Empire Engineering Company, Toronto. Plans and estimates for additions to present plants, new installns., modernization of existing equipment, supervision installns., directing acceptance tests, estimating costs of repairs and reconditioning, etc. Equipment sales and service. (*Affil. 1931.*)

References: C. S. L. Hertzberg, R. E. Smythe, W. S. Wilson, M. N. Hay, W. G. Milne.

The Bristol Company of Canada Limited announces that on March 1st, 1935, it doubled its factory space at 64 Princess Street, Toronto. This Company was incorporated a little over a year ago, both to serve the Canadian market for Bristol's instruments and to expand and consolidate the service laboratory that for twelve years previously had been maintained in Toronto.

The factory is equipped with facilities for making and testing gauges, thermometers, controllers, voltmeters, recording ammeters and other instruments of the Bristol line.

Canadian distributors of Bristol's products are Powerlite Devices, Ltd., Montreal and Toronto; Gorman's Limited, Edmonton, Alta.; and Filer Smith Machine Company, Winnipeg, Man.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Civil Service Vacancies

List No. 617

The Civil Service Commission announces open competitive examinations for the following positions:

ASSISTANT OFFICE ENGINEER (MALE)

23866.—An Assistant Office Engineer (Male), in the Chief Engineer's Branch, Penitentiaries Branch, Department of Justice at Ottawa, at a salary of $2,160 per annum, subject to such deduction as may be provided for by legislation.

Duties.—Under direction, to assist in the work of the Chief Engineer's Branch, Penitentiaries Branch, Department of Justice; to prepare plans, estimates, specifications and bills of materials, and to perform other related work as required.

Qualifications.—Education equivalent to high school graduation; either graduation in engineering from a school of applied science of recognized standing with at least three years of experience in field or office engineering construction work, or five years of experience in field or office engineering construction work including in each case at least one year in a position of professional responsibility; considerable experience in preparing estimates, specifications, and bills of materials; accuracy, thoroughness and good judgment.

While no age limit has been set age may be a determining factor in making a selection.

While temporary appointment only may be made at the present time this examination will qualify for permanent appointment. In the event of permanent appointment the initial salary of $2,160 per annum may be increased upon recommendation for efficient service at the rate of $120 per annum until a maximum of $2,580 is reached.

ASSISTANT MECHANICAL ENGINEER (MALE)

23865.—An Assistant Mechanical Engineer, in the Penitentiaries Branch, Department of Justice at Ottawa at a salary of $2,220 per annum, subject to such deduction as may be provided for by legislation.

Duties.—To assist in designing and preparing plans and estimates of various engineering and construction projects, including mechanical heating and ventilation equipment, steam power plants, installation of electrical equipment of various kinds, and to perform other related work as required.

Qualifications.—Education equivalent to High School graduation; either graduation in Mechanical Engineering from a school of applied science of recognized standing with three years of experience in Mechanical Engineering, one year of which shall have been in a position of professional and supervisory responsibility; or, five years of Mechanical Engineering experience, one year of which shall have been in a position of professional and supervisory responsibility; preferably experience in general construction engineering; tact and good judgment.

While no age limit has been set age may be a determining factor in making a selection.

While temporary appointment only may be made at the present time this examination will qualify for permanent appointment. In the event of permanent appointment the initial salary of $2,220 per annum may be increased upon recommendation for efficient service at the rate of $120 per annum until a maximum of $2,700 is reached.

Nature of Examination.—A rating on education and experience will be given from the sworn statements, supporting documents and other evidence submitted by applicants on and with the application forms. Applicants must give full particulars concerning their technical training and experience, especially as they bear on the qualifications for and duties of these positions.

An Oral Examination may be given if necessary in the opinion of the Commission. An eligible list valid for one year may be established.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, **not later than April 18, 1935.**

Application forms may be obtained from ths offices of the Employment Service of Canada, from the Postmasters at Prince Rupert, Vancouver, Victoria, Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Quebec, Fredericton, Saint John, Charlottetown, and Halifax, the Secretary of the Civil Service Commission, and from The Engineering Institute of Canada, Montreal.

Situations Wanted

ESTABLISHED SALES ENGINEER. Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

Situations Wanted

ENGINEER, A.M.E.I.C., Univ. Grad. '27, age 31, with ten years' experience in the design and construction of paper mills and hydro-electric plants, modernization of sulphite pulp mills and industrial plants, and general engineering. Available immediately. Apply to Box No. 150-W.

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; ons year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.SC. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., JUN. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrumsnt work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.SC., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

Situations Wanted

CHEMICAL ENGINEER, S.E.I.C., B.SC., Univsrsity of Alberta, '30. Age 31. Single. Six seasons practical laboratory experience, thres as chief chemist and thres as assistant chemist in csment plant; one year's p.g. work in physical chemistry; three years experience teaching. Desires position in any industry with chemical control. Availabls immediately. Apply to Box. No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty ysars experiencs in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; thres years construction engineer on industrial plants; fourtesn ysars in chargs of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as sxecutive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W

ELECTRICAL ENGINEER, B.SC. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouss Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box. No. 651-W.

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouss Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can bs verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintsnance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), O.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No. 729-W.

Situations Wanted

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No 735-W

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

Situations Wanted

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

Situations Wanted

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.Sc., Queen's '33 Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

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MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

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The New Gaseous Conductor Lamps and their Applications

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Paper presented before the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ontario, February 8th, 1935.

SUMMARY.—This paper discusses the new sodium and high intensity mercury vapour lamps, giving a description of their design and characteristics, and outlines their present and possible future applications. These new light sources have created wide interest, and this paper is intended to cover their advantages and disadvantages, and the effect they may have on lighting practice. In general, it is considered that these sources are new tools for the lighting industry that will meet with increasing use. They seem, as far as the present goes, to be unlikely to supplant, to any great extent, the incandescent tungsten lamp for general lighting service.

Many types of gaseous conductor lamps have been developed and serve a wide variety of purposes. The scope of this paper is confined to a description of the new sodium and high intensity mercury vapour lamps and their application to lighting service.

Since the days of Edison's first practical incandescent lamp, scientists have been continually striving for light sources with higher and higher efficiencies. Much progress has been made in incandescent lamps, from the 1.4 lumens per watt of the first carbon lamps to the 10 to 20 lumens per watt of our standard general service tungsten lamps today. Little can be hoped for in greater efficiency with the present types of lamps.

It has long been known that some gases, particularly sodium, gave high luminous efficiencies, but previously these were treated largely as experimental laboratory curiosities. Mercury vapour has been used for many years as a light source in low pressure tubes for photographic and general industrial lighting, since the start of the development of practical gaseous conductor lamps by Peter Cooper Hewitt in 1902. The commercial application of the newer types of lamps was first begun in Europe in the summer of 1932. The first installation given publicity was the lighting of a mile of highway in Holland with Philips sodium vapour lamps, July 1st, 1932.[1] The lamps used had a rating of between 5,000 and 6,000 lumens. They were spaced 83 feet apart and mounted 26 feet high. Leaving out of consideration any peculiar features of the sodium lighting, the installation was such as to provide a good level of illumination by means of properly placed lighting units. Comments on the lighting were favourable, as "so intense is the illumination along the roadway that, driving a car at 50 or 60 miles per hour without headlights, one feels perfectly safe."

At about this same time trials were being made of a new type of mercury lamp in England and an official opening of a street lighting installation at Wembley was held on November 9th, 1932.[2] The lamp used was a 400-watt unit with a rating of 40 lumens per watt. On December 1st, 1932, the first installation of sodium lamps for public lighting in England was announced at Croydon.[3]

Progress in the development of the sodium vapour lamp was also being made in the United States early in the year 1932, and the General Electric Research Laboratory at Schenectady announced a practical 100-watt direct current lamp giving an over-all efficiency of 34 lumens per watt, in August, 1932.[1] These announcements of new light sources created much general interest. Many people, particularly those connected with the electric light industry, wondered to just what extent past practices in lighting would be revolutionized. Some of the general public gained the impression that these new sources would become immediately applicable to all classes of lighting. Now, after two and a half years of development work and experience with these new gaseous conductor lamps, more is known of their uses and their limitations.

The Sodium Lamp

Sodium vapour lamps are now available in this country in 500, 4,000, 6,000, 10,000 and 15,000 lumen sizes for operation on a.c. circuits. The 500-lumen lamp is designed for use in a Lab-arc unit for laboratory experimental purposes. The lamp on which most development work has been done on this continent is the 10,000-lumen lamp. This is used in most of the present installations here, so that for the purpose of this paper the description given will refer specifically to this lamp, which is typical, however, of sodium lamps in general.

The present form of 10,000-lumen a.c. sodium lamp consists of a long bulb of special glass enclosing at each end an oxide coated filament which serves as a cathode, and a metal cylinder surrounding the filament which serves as an anode. Thus this lamp has two cathodes and two anodes which serve during the appropriate half-cycle. A small quantity of metallic sodium and some neon gas at a pressure of about 1.5 mm. or more are included in the bulb. When the lamp is first turned on the discharge takes place through the neon gas which serves to start the sodium discharge by heating and vaporizing the sodium. Thus the appearance at first is that of a neon lamp, but the characteristic yellow glow develops as the sodium warms and becomes predominant in about five minutes. However, it takes from twenty to thirty minutes for the lamp to come up to full candlepower.

The bulb containing the sodium is coated on the interior with a sodium resistant glaze of borosilicate to prevent the attacking of the glass by the sodium and the resulting discoloration of the bulb. The development of sodium-resistant glasses or glazes to be applied to commercial glasses, was one of the chief problems in the making of a practical sodium lamp. Not only was it necessary to produce a glass that would resist the attacks of the sodium, but this glass had to have the quality of being workable

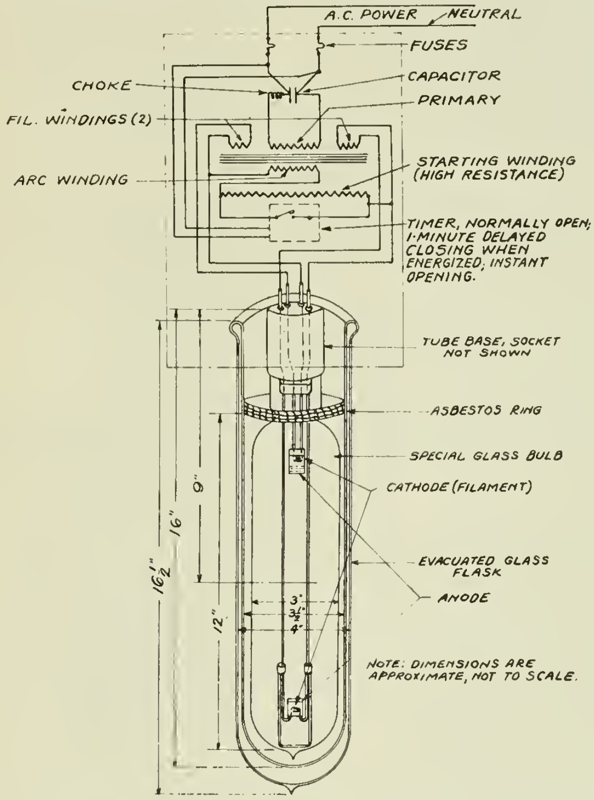

Fig. 1—Schematic Diagram, 10,000 Lumen A.C. Sodium Lamp

so as to permit fabrication of lamps. The best solution seems to be that described above, of coating the interior of a commercial hard glass bulb with a sodium-resistant glaze which prevents penetration by the sodium atoms. This glazing gives to the bulb the appearance of the familiar inside frosted bulbs of incandescent lamps.

The sodium lamp bulb which is approximately 3 inches in diameter by 12 inches long, is enclosed in a double-walled vacuum flask having an outside diameter of 4 inches and an over-all length of 16½ inches. Asbestos washers around the neck of the bulb fill the open end of the vacuum flask to prevent heat loss. The vacuum flask is indispensable to the operation of the lamp, since a temperature of about 220 degrees C. is required to provide the most desirable vapour pressure of the sodium, of about 0.2 microns.[4] The attainment of maximum light output and maximum efficiency depends upon this critical temperature. When equipped with the vacuum flask and as used in commercial luminaires, most of which have a heat-conserving influence, the variations in efficiency are not great for even the wide ranges of summer and winter temperatures. The result of one test showed a decrease in lumens of only 6 per cent for a change from room temperature to −30 degrees C.[5]

Operating Characteristics of 10,000 Lumen A.C. Sodium Lamp

Three inherent properties of the sodium vapour lamp govern the design of the electrical circuit whether for a.c. or d.c. operation[6]:—

1. Sodium vapour lamps, like all gaseous discharges, have an arc volt-ampere characteristic, that is, the voltage drop is independent of current or else it decreases with increase of current. This property of a gas or vapour lamp necessitates the use of special series elements of reactance or resistance for the purpose of limiting the current to the desired value.
2. The cathode requires a heating current and must be "pre-heated" before the arc is started.
3. The starting voltage of the lamp is higher than the operating drop.

The 10,000-lumen arc lamp is designed for operation on a 6.6 ampere street lighting circuit. Figure 1 gives a schematic diagram of this lamp and auxiliary equipment for series circuit operation. The 6.6 amperes for arc current can be supplied from a transformer with 6.6 ampere or any other normal primary current rating. Inasmuch as a cathode heating period of about a minute is required before the arc is struck, a time-delay device is incorporated in the equipment to delay the starting by this length of time. A radio filter condenser and ratio-frequency choke coil are included to eliminate any radio interference.

The 10,000-lumen a.c. sodium lamp can be operated directly from a 115 volt a.c. multiple circuit by means of a device to provide an inductive kick for starting and the necessary auxiliary equipment for controlling the current and voltage.

High Intensity Mercury Vapour Lamps

The new mercury vapour lamps are now available in 250-watt and 400-watt sizes. The 400-watt lamp was initially developed and has been used in most installations up to the present and the description given in this paper will be confined to this size.

The 400-watt high intensity (high pressure) mercury vapour lamp consists of a tubular light source surrounded by a heat-conserving jacket, fitted wtih a mogul screw base. The high intensity mercury lamp differs from the familiar Cooper-Hewitt type or low pressure lamp, in that the pressure of the new lamp runs much higher, though still not above atmospheric, and the lamp is of smaller dimensions. (See Fig. 2.)

The light source is contained in an inner glass bulb 1⅜ inches in diameter and 9 inches in length. This inner bulb is mounted concentrically in an outer glass bulb which is filled with a low pressure of nitrogen to prevent too rapid dissipation of heat. The complete lamp is 2 inches in diameter by 13 inches overall in length. The inner bulb contains a small amount of mercury and a low pressure of argon gas for starting. A band of wire gauze placed on the outside of this bulb near one electrode facilitates starting. No preheating of the electrodes is required and the lamp will operate on a 230-volt a.c. circuit with no other regulator than a choke coil in series to provide the reactive steadying effect. For operation on 115 volts a transformer to step up the voltage may be used, and equipment of this design is now available.

The arc appears as a brilliant pencil of light at the centre of the cylindrical tube. This is in contrast to the sodium and low pressure mercury lamp where the glow seems to fill the entire diameter. It is necessary to operate the lamp in a vertical position to prevent injury to the glass from the heat of the arc, although lamps of this type for horizontal burning have now been announced.[7] The control of the luminous stream so as to prevent it impinging on the glass and consequent overheating is effected by means of electro magnets placed in proximity to the tube.

Efficiency

It is the high actual and even higher theoretical efficiencies of these new light sources that are of most interest in regard to their applications. If all the energy of a light source were emitted at a wave length of 5,550 *A*, the peak of the relative luminosity curve, the luminous efficiency would be 670 lumens per watt. For sodium, one-quarter of the energy is emitted in the infra-red and small amounts in other lines besides the sodium *D* lines. The maximum possible luminous efficiency of a sodium source is about 360 lumens per watt, and this has been reached in the laboratory.[2] However, a value as high as this is not practical, but under good conditions efficiencies of 70 lumens per watt seem possible. In practical sodium lamps of present manufacture 40 to 50 lumens per watt are assured, and there is good reason to believe that higher efficiencies can be secured with further experience and improvement. The present 10,000-lumen a.c. series lamp is rated at 40 lumens per watt.

Theoretically, mercury arc lamps do not offer as high possible efficiencies as the sodium lamps on account of the spectral character of the luminous flux. However, comparatively high efficiencies have been obtained in experimental lamps and the present practical 400-watt high intensity mercury lamp is rated at 35 lumens per watt or overall lumens per watt of about 32 when the reactor is included. The high intensity mercury lamp as generally used here and in Europe is a 230-volt lamp. This lamp shows a greater improvement in efficiency over the standard Mazda lamps in England, which are generally of 230 volts rating, than over Mazda lamps in this country which are designed for 115-volt circuits. Incandescent lamps of the

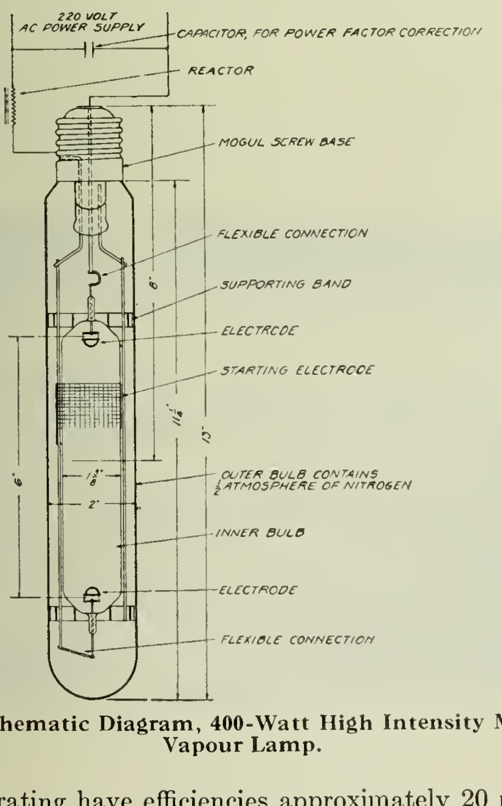

Fig. 2—Schematic Diagram, 400-Watt High Intensity Mercury-Vapour Lamp.

115-volt rating have efficiencies approximately 20 per cent higher than 230-volt lamps. This explains to some extent the more extensive use of these new sources in Europe.

Consideration must be given as well to the economic efficiency in a practical installation as well as the efficiency of the source itself. As compared to incandescent lamp installations, the cost of auxiliary equipment and installation is higher with these new units. In addition the average lumens maintained throughout life is a lower percentage of initial lumens for the gaseous-conductor lamp than for Mazda incandescent lamps. In general, the new gaseous conductor lamps fall off in candlepower, so that the average efficiency throughout life is approximately 80 per cent as compared to an average efficiency of 90 per cent or better for incandescent lamps.

In making a final comparison of the new lamps and the present-day incandescent lamps it is largely the average or effective lumens on the work that should be considered.

The Colour of the Light

The sodium lamp has a characteristic orange-yellow colour, quite similar to that produced when common salt is dropped into a flame. It is practically a monochromatic light source with most of the light in the sodium *D* lines of the spectrum equivalent to the wavelength of 5,893 Angstrom units. Thus, under this light all of the other colours are distorted. This distortion may be an advantage for certain particular operations, but in general is a distinct disadvantage for the usual visual tasks.

The spectrum of the mercury vapour lamp consists of lines or bands characteristic in wavelength and energy content of mercury. The light of the high intensity mercury vapour lamp has a higher percentage of green and yellow than the familiar low pressure tubes. While the light has the same bluish-green characteristic, the appearance is that of a "whiter" light source. This light is comparatively monochromatic in character in that most of the luminous flux is in the yellow-green band.

The high intensity arc has a small amount of red light although still quite deficient in this portion of the spectrum to give satisfactory renditions of objects with red colours. The red component can be improved by the addition of cadmium or zinc, but the gain in colour is secured at a sacrifice in efficiency. Estimating the red from the incandescent lamp at 25 per cent, from daylight at 15 per cent, and from the high intensity mercury vapour lamp at one per cent it has been found that the latter could be increased through additions of cadmium and zinc by one per cent gain in red at a loss in efficiency of about 10 per cent.[8] In view of the fact that the deficiency in red can be so easily made up by the use of incandescent lamps, the above modification of the mercury arc hardly seems justifiable.

Flicker

Both the new sodium and mercury arc lamps fall off in candlepower during the passing of the current through zero on alternating current circuits. On 60-cycle circuits this fluctuation is hardly noticeable and not at all objectionable for most applications. It is only in the case of the illumination of high speed machinery that care needs to be taken in providing illumination from these sources in order to avoid stroboscopic effects. However, it is found that safety guards and surrounding equipment of this nature are likely to quite effectively eliminate any annoyance from this character of the light.[9]

On 25-cycle circuits the flicker is quite pronounced, and so objectionable as to be impractical in ordinary interior lighting installations. The effect out of doors, however, has proved to be acceptable and it may be that these lamps can be used on 25-cycle, particularly where 3-phase is available in large interiors, and where some flicker is not a serious handicap.

Power Factor

The power factor of the 10,000-lumen a.c. sodium lamp is about 90 per cent.

The power factor of the 400-watt multiple high intensity mercury lamp on 220 volts with reactor only is approximately 60 per cent. This value can be corrected to above 90 per cent by the use of a condenser.

The Applications of Sodium Lamps

Since the first installations in Europe the new sodium lamps have found their application in highway lighting largely. There are perhaps three particular reasons for this. In the first place, highway lighting is one of the undeveloped fields of lighting where a high efficiency source like the sodium lamp offers an incentive to provide lighting and so correct the uneconomic condition of dark highways. Secondly, the sodium lamp is particularly adapt-

Fig. 3—Model Highway for Laboratory Experimental Purposes.

able to series circuits which have an advantage in control and distribution for this service. And thirdly, the colour of the light not only seems less objectionable in this application but actually appears more satisfactory than incandescent lamp lighting. This general impression is due perhaps largely to the different effect of this lighting which causes the highway to stand out distinctly and to the lower brightness of the light sources with the resultant minimized glare.

While it is known that the monochromatic sodium light is better than light of all colours of the spectrum where visual acuity is concerned, it is not definitely known that this is the reason for the favourableness of the sodium lamp for highway lighting. It has been estimated that visual acuity is three times as good under sodium illumination as under incandescent lamp illumination. In fact investigations by Luckiesh and Moss indicate that 5 foot-candles of this light are as effective in revealing fine detail as 20 foot-candles of incandescent light.[10] However, visual acuity is a factor that plays little part in visibility on highways. What one is more interested in here is the contrast between objects and the background, and in this latter regard sodium light seems to have an advantage for objects of some colours and for silhouette vision.

In an effort to determine the relative advantages of sodium light for highways where conditions could be carefully controlled and numerous observations taken, a model roadway on a ⅛ scale was constructed at Nela Park, Cleveland, last summer.[11] The road surface is 250 feet long and therefore represents approximately 2,000 feet of street. (See Fig. 3.) It is equipped with several similar systems of incandescent lamps and sodium lamps which give substantially identical illumination values on the street and equal candlepower toward the eye. When observations are made, the subject is seated at the end of the street in a position relative to the road surface, similar to that which he would occupy in the driver's seat of an automobile. Now several thousand observations indicate that there is no substantial difference foot-candle for foot-candle between the sodium and incandescent lighting in revealing objects according to the engineers who have been conducting the test.

In a true comparison of sodium and incandescent lighting, it is necessary to take into consideration not only the cost per lumen delivered on the roadway, but also such factors as glare, contrast, reliability, simplicity, etc.

In Canada there are two trial installations of sodium lamps, one just outside Three Rivers, where ten lamps are installed[12], and one near Stoney Creek on the Toronto-Niagara highway, where four units are used. Other installations of a small number of units may have been made.

As more satisfactory sodium lamps for multiple circuits are developed it is not unlikely that they will be extended in their use to other fields than highway and street lighting. For the lighting of large areas the increased efficiency may be found advantageous. Such fields as railway yards, athletic grounds, parking areas, racetracks, etc., are possible applications. When the higher levels of illumination are required and persons come within the range of this illumination in their activities, the sodium lamp is at a distinct disadvantage. Persons look singularly unattractive when viewed under this light. This colour disadvantage places a great handicap on the sodium lamp for extended application outside the fields mentioned above. It is particularly unsuited to home and commercial lighting.

Reflectors for Sodium Lamps

This new light source not only brought to the illuminating engineer new ideas of an illuminant, but also new requirements in reflecting and distributing equipment. The sodium lamp may be burned horizontally, as well as in any other position, so that its extended light source offers a particular advantage for highway lighting and also demands a new design of reflecting medium.

One type of equipment that has proved effective is the airplane design of unit illustrated in Fig. 4. It is interesting to note, as well, that the reflectors of this luminaire are made of aluminum treated with the new "Alzak" process which provides not only high efficiency but also good permanence in its reflecting power, since the surface is impervious to atmospheric conditions. The initial reflecting efficiency of this surface is about 82 per cent.

A few other types have been produced on this continent, and in addition, standard street lighting units

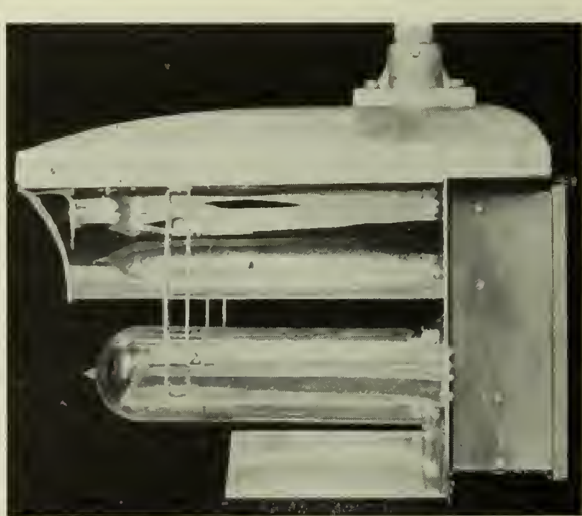

Fig. 4—Sodium Luminaire.

have been adapted to accommodate the sodium lamps. Many new designs of equipment have been developed in Europe for sodium lamps.

Applications of High Intensity Mercury Vapour Lamps

For many years mercury vapour lighting has been used successfully in various industrial applications and in other specific fields, such as the photographic. The advent of the new high intensity mercury lamp did not constitute as marked a change from past practice as did the introduction of the sodium lamp. The new mercury lamp, however, has a much higher efficiency, a somewhat whiter appearing light, and a form and size more akin to the common incandescent lamps than the elongated low pressure mercury vapour tube. These three different characteristics make the new lamp applicable in many fields where the older type was unsuited.

For the present the new uses seem to be largely in street lighting and in high bay lighting in factories and larger buildings. For street lighting the mercury arc is not so radically different from the carbon arc street lights still used to good advantage in many cities. The mercury light is lacking in red, but this deficiency can readily be corrected or relieved by the use of incandescent lamps in combination with the mercury lamp. The incandescent lamp serves two further purposes, particularly as used in this climate, first improving starting conditions of the mercury lamp in cold weather, and second, serving as a standby light source in case a momentary power interruption causes the mercury lamp to cease functioning for a time, until it has cooled sufficiently for the pressure to drop to a value where the lamp will start. While complete data are lacking it is generally considered for the present that as far as cold weather operation goes, the high intensity mercury lamps may not start at temperatures much below 15 degrees F.

The enclosing of a single 200-watt lamp or combinations of more than one lamp in a semi-enclosing globe with the mercury lamp serves to provide sufficient heat to bring the temperature to a satisfactory point for the starting of the mercury lamp.

Similar to the sodium lamp the high intensity mercury lamp requires from fifteen to twenty minutes or longer to build up to full candlepower.

Lighting Equipment for High Intensity Mercury Lamps

While in a few instances manufacturers in America have given some consideration to the design of new reflectors and luminaires for the new mercury lamp, for the most part the use of these lamps up to the present time has been confined to either standard equipment or that equipment with slight adaptations. Satisfactory distributions of light can be obtained from standard high bay units, industrial and commercial units of some types and street lighting equipments of proper size. In England many new designs of equipment have been developed, chiefly for street lighting.[13]

In the design of equipment the chief problem is that arising from the long narrow light source as distinct from the small source of the incandescent lamp which for many purposes may be considered as approaching a point source.

Combination Units

The incompleteness of the spectra of the gaseous conductor lamps, particularly in red radiations, has led to the idea of combinations of these lamps with incandescent lamps for general lighting purposes. The incandescent lamp has a complete spectrum and has an abundance of red and yellow rays.

Since incandescent lamp light is yellow as compared to daylight or white light, the addition of this to the already predominantly yellow light of the sodium lamp does not constitute much in improvement in the general quality of the illumination. Therefore little use has been made so far of combinations of incandescent and sodium lighting.

The condition however is very different where the new mercury lamp is concerned. The addition of incandescent light to the mercury light completes the spectrum in a relatively satisfactory manner. Experiments to date indicate that for a daylight effect a mixture in the proportion of 60 lumens incandescent to 40 lumens high intensity mercury is about right. This means that from two and a half to three times as much wattage in incandescent lamps is required as in high intensity mercury lamps. The effect, of course, of the combination is to produce a luminous efficiency somewhere between that of the two different light sources, so that in this regard the combination unit is in a much less advantageous position than the mercury lamp by itself. No combinations of mercury vapour and Mazda lamps exactly reproduce daylight, and so are not satisfactory for accurate colour matching.

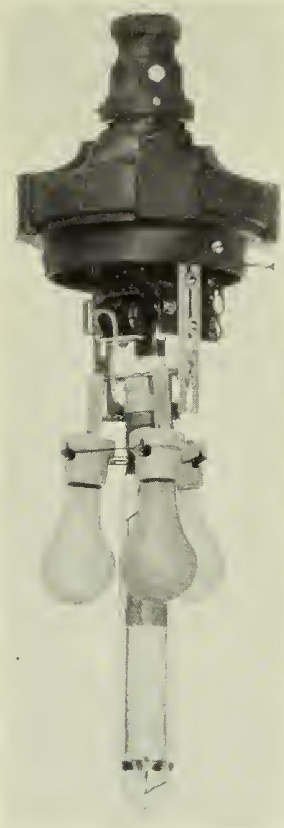

Fig. 5—Bracket Type Mercury Arc Incandescent Luminaire, without Globe.

The following is a table of overall efficiencies of generated light for combinations of lamps, bare lamps only considered.

	Generated Lumens	
Mercury lamps alone (400 watts)	35	lumens per watt
Mercury-Mazda Combination— equal watts (2-200 watts)	26	" " "
Mercury-Mazda Combination— equal lumens (4-200 watts)	23	" " "
Mercury-Mazda Combination— 43-57 lumen ratio (4-250 watts G-30)	23.4	" " "
1,000 watt Mazda Lamp alone	20.8	" " "
500 " " " "	19.5	" " "
200 " " " "	16.7	" " "

While the overall efficiencies of combination units are lower than that of the high intensity mercury lamp alone, they are nevertheless much higher than the efficiency of Mazda Daylight Lamps. Thus where a daylight appearance without accurate colour discrimination qualities is required, the combination units permit the illumination to be obtained much more efficiently than by daylight lamps or luminaires.

In general, multiple lamp units involve greater difficulties in the efficient reflection and distribution of the light so that from the standpoint of effective light control and utilization combination units are usually at a disadvantage to single lamp types.

Some very satisfactory experimental indirect combination units have been developed. By mixing the light in an indirect manner, good distribution is obtained and good mixing of the light. Luminaires of this type with mercury and Mazda lamps will find application in store lighting where an abrupt change between the colour of daylight and the artificial lighting in the interior is undesirable. It will also be found that the light from combination units mixes better with daylight, so that these combination units will provide ideal sources for supplementing daylight in office buildings, schools, exhibitions, etc.

Likewise, combination units of mercury and Mazda will find acceptance in industrial plants, arenas, and like places. The Glassteel Diffuser type of luminaire has been adapted in an experimental way to accommodate four or five 150-watt incandescent lamps with one 400-watt mercury lamp. Other arrangements in specially designed reflectors are possible.

Combinations of two separate systems of lighting—one for mercury lamps and one for Mazda lamps—have already been used in a number of installations. This plan is perhaps best suited to high bay lighting, where the units are mounted well above the work. The high mounting makes possible a reasonable mixing of the light without an extremely close spacing of the lighting units. In some instances the layout is planned for a standard Mazda lamp system and then high intensity mercury vapour units substituted for alternate units. The incandescent lamp system serves to provide better colour rendition and also as a standby during the retarded starting of the mercury units in the case of a circuit interruption. The high intensity mercury light adds any improvement in visibility due to the mercury spectrum, gives a more "daylight" effect to the illumination, and increases the efficiency of the lighting system.

The providing of a daylight effect by the additive method by using mercury and Mazda illumination together is a more efficient method than by the use of daylight glass or daylight bulbs with incandescent lamps.

Conclusion

It is difficult to predict what will be the ultimate place of the gaseous conductor lamp in the lighting of the future. That they will occupy an increasingly prominent position seems certain. As experience is gained in their uses and in their manufacture, improvements will be accomplished. While during the introduction of these light sources up to the present the installations have been considered largely of an experimental nature, now the practice regarding their use has become quite well established and installations of any magnitude are being undertaken.

Improvements in the near future in life, average efficiency, uniformity, colour of light, simplicity of operation, and in cost of production, are hoped for. Whether or not they will eventually supplant the incandescent lamp for general lighting is a question that only the future will answer. For the present it appears that they offer an additional type of light source that will find application in the extension of artificial lighting into new fields and in present uses where alone or in combination with Mazda lamps more effective lighting results are obtained. The gaseous conductor lamps seem to have, inherently, limitations which will prevent their taking the place in any large measure of the simple and convenient electric lamps as known today.

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DISCUSSION

L. P. Rundle, M.E.I.C.[1]

There is a highway lighting installation on the Hamilton-St. Catharines highway at Stoney Creek, consisting of four 10,000-lumen sodium type lamps on 66 cycles. The writer has passed through this installation several times late at night in both bus and automobile. In the lighted zone headlights were turned off and it appeared that with the present installation one would be more safe in driving around 40 to 50 miles an hour than with the usual automobile headlights. The driver of the car, however, thought conditions better with his dim lights on as these lights, having a wide beam spread, helped light the ditches. Other motorists state that sodium lamps are the only light of any practical use when driving in heavy fog. Objects stand out quite clearly and a man walking ahead of a car is distinctly outlined and has no appearance of fading into the background at the sides of the highway, thus indicating clear contrast. There appeared to be no noticeable cycle flicker. However on 25-cycle there might be some flicker under certain conditions. If the lamps on 25-cycle were fed alternately from a two- or three-phase supply it is likely that the average illumination would tend to neutralize any flicker and consequent eyestrain. The Stoney Creek illumination appears to be easy on the eye and remarkably free from blinding points of light reflected from the polished road surface and engine hood of the automobile as compared with the ordinary lamps and lighting.

The writer is of the opinion that the lighting would be improved if the units were mounted higher, and if the unit itself had more area, thus decreasing the intensity of the light per unit area. Some people take exception to the colour of the light, others do not. There is no doubt that further research and experiment will improve these lights in both colour and efficiency as well as simplify and reduce the auxiliary equipment now necessary for their operation. The writer is of the opinion that lighting of the more congested highways is necessary to reduce the heavy toll of accidents and fatalities due to night driving, and of all the schemes this type of lamp appears to be considerably superior to any other practical type of lighting unit now in use, including the best of present-day automobile headlights.

A. J. Hodgson[2]

When in England a few months ago, the writer had the opportunity of viewing some of the new lighting installations there.

[1] Senior assistant engineer, Welland Ship Canal, St. Catharines, Ont.

[2] Hydro-Electric Power Commission of Ontario, Toronto, Ont.

Forty thousand units were in use in England last year and a large number in the process of construction. There were also a number of installations of the mercury vapour method used in large stores with a most pleasing effect. Further different councils were arranging for imposing schemes for their respective areas.

One particular feature which was noticed, was the high, even brightness of the roadways, with an absence of glare. The type of fixture used appeared to throw more light in the direction in which the traffic was proceeding than it did toward the traffic. In actual test on a highway, a pedestrian could be seen 2,000 feet away.

It would be difficult to find a better system of lighting to reduce accidents on highways than the system that has been described.

J. A. Langford, A.M.E.I.C.[3]

In connection with the slides of highway lighting installations in England shown by Mr. Hodgson, there seemed to be much less glare coming from the lights themselves. Is this due to the reflectors designed for and used with those lamps?

[3] Electrical Engineer, Canadian and General Finance Company, Toronto, Ont.

J. W. Bateman[4]

In reply to Mr. Langford's question the author observed that there are perhaps two reasons for the lack of glare. In the installation shown in England the intensity of illumination is higher and the spacing of the lamps is closer than in the highway lighting installations here. It must be remembered that the slides shown of the English installations were real street lighting installations where the units were spaced closer together so as to obtain a more even light along the street than in the slides showing the installations here where you have the units placed much farther apart for highway lighting. Also, the English units have not quite the same directive character as far as directing the light in a wide beam, because the particular unit illustrated has an opal glass side which cuts down the brightness to some extent. Then too, the design of the unit is such as to throw the higher candlepower away from the approaching driver. There are units on both sides of the street so that the unit on the side on which one is driving would tend to throw the light away rather than towards you.

[4] Manager, Lighting Service Department, Canadian General Electric Company Ltd., Toronto, Ont.

The Status of the Engineer

A luncheon address by J. B. Carswell, M.E.I.C.,

Delivered at the Annual General Meeting, Toronto, February 7th, 1935 (Abridged)

With regard to the status of the engineer in his own profession, it is the speaker's opinion that the heading for the papers which follow should not have included the word "status" at all. It would have been better to discuss the "stature" of the engineer, because there is a great difference between his stature and his status.

This abstract thing called "status" indicates someone at rest, someone who has ensconced himself in a certain position, and surrounded himself with barriers and fortifications, and who is not likely to move out of that position for some considerable time.

The other word, "stature," which is a materialistic and concrete quality is more appropriate; you can have stature and still be growing and walking forward amongst your fellowmen, but stature in the engineering profession or in any other profession can only be acquired by hard unselfish service to the public.

Why are we, as engineers, always so worried about our status in the engineering profession? Is there not a little nervous fear that our importance may be overlooked? Many engineers are fond of analyzing the position of the engineer in society and it is an interesting occupation to prove conclusively to yourself that without the engineer society could not exist. However, if you happened to be a law student, you could similarly analyze the situation and prove that society could not exist if it were not for law and order controlled by the legal fraternity. The truth of the matter is that all occupations are merely cogs in the wheels of industry, their usefulness is measured in units of co-operation, and that is where the average engineer falls down.

Last year the speaker criticized the agenda of the annual meeting of The Engineering Institute, and this year it should again be criticized.

Engineers are lacking in perspective. This is the year 1935, when the political pot is boiling as it never boiled before, and when the economic structure of Canada, and every country in the world, is under a severe strain. The old established orders are changing; the capitalistic system is being attacked from every side; in some countries of the world the capitalistic system has ceased to exist. Our government in Ottawa has facing it at the moment problems of vital importance which will affect every man and woman. To-day, the representatives of four thousand professional engineers in the Dominion of Canada meet, a group which is supposed to contain—and does contain without doubt—some of the best trained minds in the country. Now, the government in Ottawa is after all just a group of business men, who are at this time seeking for good intelligent public opinion as a guide for them in their actions. And what do the representatives of four thousand engineers do? The first day of their meeting is devoted to a discussion of gaseous conductor lamps and bascule bridges. What interest has the government in these subjects? And the third session—the third session is much better—something is actually being done for the public in the way of discussing the water situation and the irrigation problems out west. Incidentally there was an editorial in the paper a couple of days ago congratulating The Engineering Institute upon tackling this problem.

But, where does this group of four thousand men stand in connection with such items as unemployment insurance, old age pensions, and all the other social problems confronting the country at the present time? What are their views on the railway problem? It has been said on the best authority that the railway problem will wreck the credit structure in this country, unless a reasonable solution is found. Where do engineers stand on the housing problem. Substantially the same class of houses are being built to-day as one hundred years ago. The modern method of mass production which has made such vast changes in the production of everything else in this country has never yet been applied to the building of houses. Yet it is quite possible to build a house or a factory and apply the same method to its construction as is applied to the building of a Chevrolet car, and still erect a structure which will last and lose none of its originality.

Why is it necessary to go to Indiana, quarry tons of stone out of the solid rock, haul it a thousand miles, and finally hoist it three hundred feet into the air to form the wall of a modern hotel, when fifty other materials could be mentioned which would serve the purpose better, would be cheaper, and would impose on the steel supporting structures only about one-tenth of the weight? Why is this done? The answer is two-fold. First, because our fathers and our grandfathers and our great grandfathers did it before us, and secondly because the engineer, who should be tackling this problem, has for generation after generation treated the subject with contempt and neglect.

Who built the aqueducts in Rome? History says that Claudius Cæsar built them, but while Cæsar was in Britain fighting the Picts and the Scots there was somebody in Rome who knew the first principles of design and hydraulics, and built the aqueducts leading into Rome which stand there to-day, yet his name does not come down in history.

The engineer was then and is to-day for some reason or other always taking a back seat, retiring in modesty. Why does he do so, when at the same time he is faintly conscious of his own superiority over his lay associates. Out of that faint consciousness develops a little cynical attitude towards humanity, a feeling sired by introspection and mothered by idealization.

And so, in introducing this series of discussions this afternoon, the speaker wishes to make a plea that at the next or ensuing meeting of The Engineering Institute an attempt be made to arrange the agenda so that the public, and particularly those in authority, will welcome the coming of our annual meeting, and will look forward to some constructive guidance on the part of this great group of engineers.

Of course, it is necessary to untangle the status of the engineer in Canada, and the papers that you are going to hear are necessary, and will be very interesting, but if the average professional engineer in this country would get away from the detail of his profession sufficiently long to show the man in the street that he has real stature, then he would not have to spend time worrying about his status.

It is no doubt a pleasure to submerge oneself completely in a technical problem, to wallow in a mass of detail, and after weeks and months of concentration to emerge triumphantly with the solution—a solution which can be proved backwards and forwards, and all carefully drawn to the scale of one-half inch to the foot. When you solve a problem of that kind, it really does not matter if you have not been out of the house for a week, or read a daily newspaper for two weeks. You have solved this thing and you know it is right.

Meanwhile, England may have gone off the gold standard; Germany may have turned communistic, or Fascist, or Nazi. One doesn't really care. Possibly the future of some huge industry may be trembling on the brink; it may be the corporation for whom one is working out this problem, but what does it matter. And, frankly, one did not have to care very much in the past. There were always more and more problems to be attacked, lots of work to do, intensely interesting work, and the wheels were going around merrily.

But things are different in 1935; in fact they have been different for the last four years. The wheels of industry have largely stopped running, and the supply of problems has lessened. There are thousands of engineers in this country who have been out of employment for years, and are still out, although the wheels of industry are beginning to move again.

When this depression started there was considerable noise about "technocracy"—that is up in the attic now with other fads of the past, Mah Jong, crinolines and silent pictures. But there was a warning in technocracy which the average engineer failed to grasp. The theory the technocrat handed to us was that too much energy had been devoted to production and there had not been enough guidance and efficiency in distribution; criticism should not have been aimed at production, but at the more inefficient part of the industrial structure, lack of guidance.

Who has been responsible? Just a group of engineers, ourselves, who sit down and discuss at annual meetings the details of bascule bridges, when they should be out performing some good service for the public, and giving the public the benefit of their training and their brains.

Every engineer should be wakened up to the fact that in this mechanical age of progress, if he is ever to acquire real stature in this country, he will have to get out in front of the business mess in which all find themselves to-day, a mess for which he is in a great measure responsible. Away out in front, applying the same logical principles to the present problems as in the past have been applied to production problems. The engineer may have to learn a new language. He may have to discover his lay-associates, to find out who these strange creatures are, before he can be much use, but having served his apprenticeship out in front, where he is performing a real service to the Dominion of Canada, then, and only then, can he look in the mirror, once in awhile, and congratulate himself, not on the status of the engineer in his profession, but on the stature of the engineer in the economic life of Canada.

The Engineer and Industry

R. E. Smythe, M.E.I.C.,
Director, Technical Service Council, Toronto, Ont.

Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Toronto, Ont., February 7th and 8th, 1935.

This paper is an attempt to discuss briefly a number of factors related to the whole subject of the "Engineer and Industry," rather than to deal exhaustively with only one phase of it.

Definition of an Engineer

Just who is the engineer in modern industry?

From general observation, it might be said that he is that man who supplies, and applies, technical and scientific information and direction, wherever complexities of discovery, production, design, processing or distribution exist.

This definition covers a wide field of technology; it includes many new developments in Canada, and the use of men with engineering and scientific training in these new branches is increasing year by year. The demonstrated ability of engineers to adapt their technical training to the ever-changing requirements of industry and business is indeed amazing, and as industry becomes larger, the call for men with an engineering training becomes greater. More specialization is required, and administration becomes more involved.

Status of Engineers in Industry

The great variety of endeavour now followed by engineers in industry, makes training a complex procedure; likewise, it makes any attempt to set standards of professional status almost an impossibility.

The engineer in industry is a professional man, and no doubt exists on that point. He professes and makes open declaration that he is in possession of knowledge over and above that possessed by Mr. Average Citizen. Lives of thousands depend on his skill, and industries constantly advertise this applied knowledge as a feature of their products, whether motor cars or paint. Yet the engineer becomes part of his industry, and largely relinquishes any professional title he may hold. The terms are recognized at once, supervisor, superintendent, manager or president. These titles gives indication of the status of the man in the industry, but not of his status in his profession.

In the past engineers have adopted several ideas to maintain and make known their technical status. They use university and professional degrees. This Institute has had experience in the adding of A.M.E.I.C. and M.E.I.C. after members' names. In one country, engineers have attempted to add the word "engineer" before plant titles, such as engineer-superintendent, or engineer-manager. In industry the titles of plant engineer, maintenance engineer, designing engineer, production engineer and sales engineer are used, but these titles do not indicate status or seniority, as much as specialization. They all, however, do suggest that the man involved professes a knowledge of engineering or technology.

It is not easy to see how professional engineering status can be indicated in industry by title, nor is it clear that this is essential. The point one should be concerned with is the engineer's real status; in other words, how can such an organization as The Engineering Institute of Canada serve the engineer, enable him to give greater service and better leadership to his industry, and to the people depending on him in that industry.

The growth of industry in Canada, in recent years, is well known, and it is unnecessary to quote figures on this side of the question; but the increase in the number of technical graduates from universities in response to the growing demands of industry, is not so well known.

The following figures show the trend towards the more industrial branches of engineering, such as chemical, mechanical or electrical, and this trend has increased enormously in recent years.

The average number of students graduated per year in civil engineering during the period 1900 to 1904, was twenty-two. During the period 1910 to 1914, however, the number graduated rose to an average of one hundred and fifty. The peak was reached during this period, for during the next ten years, the number dropped to one hundred and seventeen; and in the last ten years, has shown a further decrease to an average of one hundred and six.

The number of graduates in mining has been relatively constant since 1910, as compared with the changes in other fields. Before 1910, the average graduating class in mining for all of Canada was eighteen per year. From 1910 to 1934, however, there is a slow rise from fifty to sixty-three.

In the comparatively new fields of chemical, electrical and mechanical engineering is shown most clearly the effect of the demands of a more industrialized country; the phenomenal increase in the number of electrical graduates to meet the needs of the great utilities, private and public, the steadily increasing demand for chemical engineers in the metal industries, food, textiles, oil, rubber, paper and research in every field, is most marked; and then, of course, the steady increase in the use of mechanical engineers as processing becomes more mechanized.

In the period from 1900 to 1904, the average number graduated in electrical engineering from the whole of Canada was two, although there were some combined courses with mechanical engineering; from then till the period 1910-1914, there is a sudden rise to an average of forty-two per year, a tremendous increase.

In the next ten years, ending 1924, the number in electrical engineering more than doubled. For the period from 1930 to 1934, there was an average of one hundred and twenty a year, compared to ninety-four in the 1920-1924 period. It will be seen at once that an apparent peak for electrical engineering was reached in 1930 to 1934, and it may be that this figure will decrease, because employment in electrical industries fell off in these years.

In 1900 to 1904, there was an average graduating class of three in chemical engineering in Canada; the number quadrupled in the 1910 to 1914 period, and during the next ten years increased from twelve to sixty-seven, or 500 per cent. In the last four years, the average is somewhat higher than seventy per year, and this figure does not include graduates in pure chemistry from arts colleges, which would probably increase the number to over ninety per year.

In mechanical engineering, there is a steady but rapid increase in the number graduated. The average in the period 1900 to 1904 was twenty-four; in the last four years, the average number graduated is ninety per year. The average increase from period to period is about 400 per cent.

These figures give some indication of the increasing number of young engineers entering industrial engineering fields. To keep their status in industry high, their training must be thorough, but one must guard against training more men than industry can absorb with profit.

The question of training consists of two principal factors: scientific and theoretical training in universities, and practical experience training in the industry itself. Canadian industry would do well to attach much greater importance to the building up of a junior staff and to training these young men after they are employed.

Changes in economic or national policy greatly affect engineers, both those in industry and consultant engineers serving industry; and one major factor is the growth of the international industries, with centralized research in larger countries, resulting in the enormous growth of branch plants, with their head offices lying outside Canada, where most of the technology is developed and designed.

These changes are not of long standing, but are recent and present developments. In 1920, there were about two hundred branch plants in Canada; today, there are some fifteen hundred—an increase of thirteen hundred in about fourteen years. If the status of the Canadian engineer gives concern, one must study the effects of these changes on his position and future in industry.

It happens that for many branch plants, research, development and training are largely carried on in the parent plant, and when engineers or administrators are required, they are moved from the parent plant to the branch. In isolated cases, this may not affect Canadian engineers, but with fifteen hundred branch plants, it will be seen that the problem becomes vitally important, especially if it is considered that about five hundred young engineers are graduated each year in Canada, and this number is steadily increasing.

Many branch plants are thoughtful on this point, and have a broad viewpoint, taking into consideration the local or national effects of such a policy; but others, overwhelmingly concerned with profits, take a narrow view and tend to ignore national welfare—at least, the welfare of a section of people such as engineers—and it is important that such a stratum of people be considered.

At the present time, when a branch plant wishes to import an engineer from its parent company, application is made to the Department of Immigration, Ottawa, giving the reasons for such a request. The Department then seeks advice on the question from available sources, and grants or refuses entry on the merits of the case, at the time of application. In many companies this need might have been foreseen, and Canadian engineers given the necessary training; in other words, many importations are merely a matter of immediate convenience.

It would appear that this Institute should establish a "Rule of the Road" in co-operation with the Dominion government on such problems, so that branch plants would either send young Canadians to their parent plants—to be brought back later on—or give them training in the branch plant. These companies would at least know what was expected of them; for as it is now, some find it difficult to understand why an application for the importation of a foreign engineer is refused. It is infinitely better to create a definite understanding between countries than to allow a great many small differences to arise and grow.

Imported Design

Again, a definite understanding should be arrived at concerning the importation of design for both structures and machines. Engineering design should not be imported into Canada, when it can be supplied competently in Canada at a comparable cost. To be specific, a plant should not import a design for a building when competent Canadian engineers and architects are available. Yet this was done on many occasions last year.

It should be possible to establish rules for the guidance of all concerned in these matters, and an organization like The Institute might accept leadership in this regard.

There is a secondary effect to be considered when industrial design is imported into Canada. Suppose a Canadian industry maintains an engineering and development staff, and is later subjected to competition from a branch plant where these costs (sometimes as high as 15 per cent) are charged to a market many times as large. It is obvious that the Canadian industry cannot compete for long, and will be forced to give up its technologists in Canada, and import its design at less cost. Thus opportunities for employment of engineers and development of engineering skill in this field are lost to Canada.

Some of these problems are very complicated and solutions far from simple, but they constitute a handicap to the Canadian engineer, if they are not controlled, and seriously affect his status.

How can the engineering organizations assist in improving the real status of the engineer in industry?

1. Our engineering organizations should face the fact that Canadian interests cover an enormous and detailed field, and they should encompass as much of it as they can. They should be ever-ready to enlarge their horizons, whenever they see that service can be rendered to our members, or to the nation and its people. Engineers in Canada must stop doing things by halves; they must do them wholly and find the necessary funds.

2. An organization such as The Institute should give assistance to smaller group of engineers, where it is to the nation's interest to promote the particular specialized knowledge concerned. That assistance should be given with a thoroughness that will enable our engineers to be leaders in these fields.

3. The Institute should promote whole-heartedly the use of competent engineering services to our people. Perhaps heating is more important to Canada than to most countries. A man building or buying a home who does not call in a professional heating engineer for advice loses both money and comfort in the long run. Our cities are filled with cold houses. They could be well heated, with the same or even less fuel, if systems were properly designed. However, people think it too costly to consult engineers specialized in this field. The Institute should, as an association, tell them what can be done for them, and in doing this for them, we assist ourselves.

4. The Institute should be in a position to advise universities where specialist training is needed, and certainly should be able to provide engineers in industry with a constant supply of the best technological literature pertaining to his specialty, arising in any country.

5. The Institute and interested associations, should establish, in conjunction with the government, definite understandings concerning importations of engineering services from other countries, and assist in providing the necessary information on these problems to enable fair rulings to be established.

6. The Institute and interested associations should establish definite understandings, approved by the government of Canada, pertaining to the control of importations of engineering design.

7. The Institute and other associations should lend their best talents to assist in the stabilization of the widely fluctuating durable goods industries, for the lack of such stabilization has created much hardship and a lowering of engineering status during recent years.

Conclusion

To raise the status of the engineer in industry, studies must be made of his problems, and so organize engineering associations that he can be assisted economically and thoroughly, or protected, in whatever way it can most fairly be effected. This is not the work of a year, but of years; but in this way, The Institute can serve the nation and its people, and its own members in industry.

The Status of the Engineer in Private Practice

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This paper is to some extent a matter of joint authorship. The chairman of this session and several others have taken an active part in suggesting the points to be considered, and while they cannot be held responsible for the conclusions, they should share in whatever credit there may be for the subject matter.

The subject will be discussed from the possibly limited point of view of the engineer engaged in the design and construction of buildings, including the structural, mechanical and electrical engineer. This should serve to illustrate most of the difficulties and the desires of engineers engaged in other types of private practice.

The status of the engineer depends on his relationships to those with whom his work brings him in contact:—

First— The client.

For the consulting engineer the direct contact may be with either the owner or the architect.

Second—The contractor.

Third— The public.

The principal objects to be attained may also be classed under three headings:—

First— Ability to carry out the responsibilities involved in a competent manner. This is to be attained by natural aptitude; academic and office training; experience in the office and in the field.

The last item is often lacking, resulting in impracticable design and details being called for at an increase in cost with no benefit in the final result.

Second—Full co-operation from inception to completion of the project.

This involves by each of the three parties to the production of the job, architect, engineer and contractor, a full appreciation of the functions and responsibilities of the others; and an active co-operation by means of discussion and consideration so that full advantage may be taken of the special knowledge of each of the three.

Third— Adequate remuneration for the services given. This involves the establishing of and *adherence to* reasonable schedules of fees by the architect and the engineer, with provision for severe disciplining by the governing bodies of those who do not maintain the schedule.

The faults in present conditions are well known, but our main desire at the moment is to seek ways and means of approaching to ideal conditions, instead of bemoaning present failings.

What methods are to be applied to obtain these objects? The essential thing, the basis of all improvement, is undoubtedly uniform and effective legislation developed in co-operation with our colleagues, the architects. Effective legislation will enable us to deal properly with the first and the third of the objects set forth above, i.e., qualification and remuneration.

The architects are ready and eager to co-operate in this regard, in the province of Ontario at any rate, and the author believes prompt and definite action should be taken, by the appointment of representatives of the engineers to meet with the architects and arrive at conclusions as to how best to further the desires of each profession in regard to legislation.

As a matter of practical politics it would appear that this action must be taken by the Ontario Association of Professional Engineers. The Engineering Institute of Canada has no provincial organization, and this question brings up again the necessity for close co-operation between the provincial bodies of engineers and The Institute.

The second of the objects to be attained—full co-operation in the design and execution of the job—is more involved as to method but perhaps easier of accomplishment, in that it does not involve the action of outside bodies—the Provincial Legislatures.

The main difficulty here is probably lack of mutual appreciation. The engineer is not merely a structural designer. The architect is not merely a decorator.

When an architect calls in a structural engineer as a consultant it should not be merely to give him information as to size and detail of a series of beams and columns for which the location and material is already fixed. The engineer's useful functions can and should begin at the stage when the general layout is being determined. His knowledge can be of much greater value in making comparisons as to the advantages and disadvantages of different layouts and different materials than it can be in the relatively simple, almost mechanical, computation of sizes of members, and preparation of details for their connections and so on.

This fact is not appreciated by many architects and some method of impressing it upon them is a necessary preliminary to fuller co-operation.

The same lack of appreciation is noticeable in the opposite direction. Engineers have been known to prepare plans for a great hydro-electric plant, and after everything of apparent importance was settled, to call in an architect and ask him to "pretty it up" for them.

Surely every great engineering work, bridge, dam, hydro plant or industrial plant, should be designed with real consideration to its appearance as well as its efficiency, and to give this consideration the co-operation of the architectural mind should be used, starting at a very early stage of the project.

This full and mutual co-operation is essential to true economy. The major part of large building to-day is commercial in its nature. It must earn its keep. To do this the first cost must be kept as low as possible, the operation of the building must be efficient, and the character and appearance must be such as to attract customers or tenants. To obtain all of these features a full co-operation of the two types of mind, the two methods of approach to the problem, is necessary.

We must also consider the question of the responsibility of the engineer and architect to the contractor and of proper co-operation with him. For the moment we may assume the architect and engineer as one, the designer of the building, and the contractor as the man or organization which produces the finished structure from the design.

Again the value of co-operation from an early stage is apparent. The designer may visualize what he wants, but often the question as to whether it is practicable or obtainable within the cost appropriation is a question on which the contractor can give valuable advice. Or perhaps he can suggest how to obtain the desired result by some other means that has advantages.

Having determined what is to be done, the next stage is to describe this by plans and specifications. Here it is desirable to define what should be included in specifications. The essential thing is that they, along with the plans, should set forth clearly and fully what the final product is to be, including all matters of finish, strength, durability, etc. Generally speaking they should not attempt to fix the methods by which these results are to be attained.

A specification never attempts to direct what type of hoisting equipment shall be used to set a unit of the structure, and yet it may devote two or three pages to a detailed description of the method of making a given mix of concrete, which could just as well be covered by a statement of the strength and finish required.

There are several traditional phrases or clauses often used in specifications which require analysis and correction or deletion.

"To the approval of the engineer" may be a reasonable requirement when it is applied to a matter of taste such as the shade of a finishing coat of paint or the assortment of bricks of varying shades in a wall. It is not reasonable when applied to something which can be definitely described and the variation in which may have an effect on the cost of the work.

"The decision of the engineer shall be final." Of course, there must be one master in control of the job, and the engineer is the logical man for that responsibility. The finality of his decisions should control procedure during the progress of the work, but should always leave open to the contractor an appeal from the decision after completion. Compliance with the engineer's decisions during progress, should be recognized as not in any way prejudicing the contractor's case in making appeal after completion on any items which affect his costs or time.

Another point to consider is the engineer's responsibility for errors. These may be roughly divided into three classes:—

(*a*) Errors in judgment.

(*b*) Errors involving changes which do not increase the final cost beyond what it would have been if the error had not occurred.

(*c*) Plain ordinary mistakes, due to carelessness at some stage by the engineer, and resulting in additional cost without any benefit to the owner.

For the first class, errors of judgment, there can be no financial responsibility held against the engineer. He has presumably given the best of which he is capable. If he was wrong, he will suffer in his reputation and by the loss of future commissions.

For the second class there is usually not much difficulty in rectifying the trouble. The engineer may have an embarrassing interview with the owner to explain matters, and may suffer in his standing with the owner, but that is the extent of the damage.

For the third class, errors due to carelessness which involve additional cost to the owner, my own conviction is that the engineer should assume the responsibility and pay for the cost involved. However, there is evidently a wide difference of opinion on this matter and a free discussion might help to clarify the position.

Regarding the engineer's relations with the public a few words might be said. The title "engineer" has rather a vague significance in the public mind. There is a general knowledge of the functions of the doctor, lawyer or architect, but the "engineer" is usually visualized either as a man peering through a little telescope on a tripod, or the operator of a locomotive or steam shovel. The designing engineer is little known and little thought of by the public in general.

Possibly the public mind can be educated by connecting the personality of the engineer more directly with his work. Every important work should carry a plate giving the names of those chiefly responsible for its production. Every description of an important structure, whether in news paragraph, technical article or advertisement should also carry those names.

If the engineers themselves work persistently for these objects I am confident that a great deal can be accomplished.

A summary of some of the chief items required to improve the status of the engineer follows:—

1. Proper qualification by aptitude, training and experience.
2. Co-operation with architect and contractor in design and execution of the work.
3. Co-operation between the representative bodies of the engineers and architects in obtaining adequate and effective legislation.
4. Co-operation with the architects, by means of periodic discussions, as to rules of practice, division of functions, etc.
5. Recognition of the true responsibilities to owner and contractor.
6. Education of the public by persistent publicity.

The Engineer in the Public Service

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The engineers who come under the above heading comprise that large and growing class working in the various branches of government. They may be divided into three groups:—

A. Those employed by the Dominion government
B. Those employed by the various provincial governments
C. Those employed by the governments of the cities and towns and the smaller municipalities throughout the country.

The term government will be used to cover these three classes of administration.

To these should be added the engineer officers of the defence forces who work under different conditions and should be considered separately.

The engineering activities of these governments cover the whole field of engineering and practically every variety of engineering specialist is to be found on the government staffs. The young engineer graduate wishing to engage in any particular branch of the profession can find an appropriate office in one of the government administrations.

Conditions of Employment

The conditions under which engineers are appointed and hold positions in the three classes of public service vary greatly but one feature is common to all and that is the continuing nature of the work to be done. The business of the country must be carried on, it cannot be interrupted. This business tends to grow and expand; in some cases this is due to the growth of the country and to new services which are required to meet increase of population and settlement; sometimes this is due to new inventions as was the case with radio and aviation, in both these cases the Federal government took over an infant which it nursed and developed, it carried on trials and experiments which private enterprise could not have financed and from small beginnings sprang two important government services; in other cases government has taken over services already established by private industry, as in the case of the Ontario Hydro Commission where the government took over a private electrical power plant and built up one of the most remarkable publicly owned utilities in the world, one which has covered Ontario with a network of power lines, and supplies current to its customers at record low rates.

While government administrations add frequently to their activities they never discontinue work which has once been undertaken. There may be temporary periods of slackness or of retrenchment, but once having put its hand to the plough a government administration cannot turn back, it must continue, it has established vested interests which insist on the work being continued and such pressure is difficult for a government to resist.

The young engineer entering government service is therefore justified in looking forward to continued employment in that service, he hopes for promotion in due course and expects that new activities of his department will furnish him opportunities for further usefulness and advancement.

Dominion Government: In the Federal government service this hope for security of employment is quite justified. The engineering staff of the Dominion government is under The Civil Service Act and subject to the terms of that act. The first Civil Service Act of 1908 exempted engineers, largely at their own request, and when the 1918 act included the engineers some indignant protests were made, it being contended that professional men would not compete for appointments or submit to examinations and that it would not be possible to obtain the best men or even well qualified men under a system of public competition. Experience has shown that these fears were groundless and excellent results have followed the application of this act to the engineering staff. The basic principle of The Civil Service Act is the merit system, the principle that every government position should be given to the best qualified man available irrespective of his political affiliations, that promotions should go to the most deserving and that no dismissals should be made except for cause.

The Civil Service Commission has a list of some eight hundred permanent classified engineering positions on the establishment of the Dominion government departments and appointment to these positions is vested in the commission and is required to be made without political or personal bias and purely on merit.

The conditions for examinations and the procedure for appointment to the engineering staff has varied from time to time. Last year after discussion with representatives of The Institute and of the Professional Engineers the commission adopted the following as the fundamental requirements for engineering appointments to positions of responsibility. The candidate for appointment must have "corporate membership in The Engineering Institute of Canada, or membership in a Provincial Association of Professional Engineers, or professional qualifications which would permit of such membership." To these general qualifications are added the special experience or knowledge needed for the position to be filled.

Power of dismissal exists and during the depression years had to be largely exercised. Reduction of staffs took place owing to the general financial conditions and the decrease in parliamentary appropriations, owing to reorganization in some departments and to transfer of certain activities to the provinces. The hardships incident to all these reductions were mitigated to a large extent by the working of the Superannuation Act which provides a pension for employees with ten years of service. A certain discretion was given to the chiefs of branches in the choice of dismissals and every effort was made to minimize the distress caused by these dismissals. It was provided that in the case of vacancies which had to be filled preference would be given to men who had been laid off. The good results attained were shown in the records of the Unemployment Committee of the Ottawa Branch of The Institute. Although the membership of the branch is very largely composed of Dominion government employees there was not a single case shown of an ex-government-employee in urgent need of relief and only three or four applied for employment. The unemployed list of the Ottawa Branch was made up mainly of engineers who had worked with commercial companies.

The Superannuation Act for Dominion government employees is working out satisfactorily. The employees and the government contribute equally to it, the tax on the employee being 5 per cent of his annual salary. It provides for an annual retirement allowance of one-fiftieth of the average salary for the last ten years up to a maximum of thirty-five fiftieths. The widow will draw half as much. This act has only been in force since 1924 so its financial results have not yet appeared, but the fund at present shows a large reserve.

The Dominion government has built up a strong engineering service in its different departments. The morale is good, co-operation between different branches is assured by inter-departmental committees which avoid duplication of effort. The men of many years of service who have attained experience and skill are attached to the service and retained by the Superannuation Act so that they hesitate to accept positions in commercial life though the financial conditions attached are frequently very attractive.

Provincial Governments: Conditions of employment with the provincial governments are not as satisfactory as with the Dominion government. Civil Service Acts in the provinces are incomplete or lacking and do not provide for the employee the protection extended to him by the Federal Act.

A few provinces recognize membership in their Professional Association as qualification for appointment and this is a step in the right direction, but most of them have no definite standard for appointment and promotions and these are frequently made for personal or political reasons and not for merit. The provinces have power to legislate in social service matters and have all passed acts providing protection for various classes of labour. They have generally failed to apply the same principles to their own employees and have left them exposed to the hazards of political patronage.

The engineers in provincial services are protected to some extent by the fact that an incoming administration can hardly proceed with wholesale dismissals in the engineering staff owing to the difficulty of building up a new technical staff, but this is no comfort for the individual engineer who is removed for political reasons or to make way for a political appointee. Provision for superannuation in provincial service is generally lacking or is elementary and does not provide sufficient definite safeguards in the case of removal or old age.

Municipal Governments: In Canadian cities party politics are replaced by ward politics. Engineering appointments are largely determined by considerations of personal friendship and family influence. Promotions and increases of salary are not entirely the result of merit, they have to be voted by council and are therefore subject to wire pulling and all kinds of local influences. On the other hand municipal engineers are seldom dismissed except for cause. Once an engineer has been in office for several years and has established friendly relations with the controllers and the aldermen his position is reasonably secure, but he needs to avoid friction with the members of council and to secure their goodwill.

Superannuation systems are generally lacking in municipalities, an old official may be pensioned but only as a special case, it needs a vote of council and is therefore dependent on its goodwill.

In the large cities the engineer has good scope for his abilities and reasonable chances for promotion. In the small municipalities there are fewer opportunities and hope of advancement is based on transfer to the larger town or city.

Standing in the Community

The engineers employed by Dominion and provincial governments at headquarters suffer from lack of personal recognition of their work, most of their work is anonymous; advertisements calling for tenders are signed by the secretary of the department, the contracts are signed by the minister. The engineer who designed the structure very seldom gets any recognition. In this they share the fate of the engineer employed by a large corporation whose work is credited to the corporation. There are a few exceptions to this rule; the Marine Department publishes charts which, following the practice of the British Admiralty, carry not only the name of the chief hydrographer but also the name of the chief of party and his assistants who made the survey; the Department of Mines issues reports signed by the engineer who made the survey; but as a rule the engineer on a large headquarters staff gets very little publicity for his work, his recognition only comes from his inner consciousness and the regard of the small circle around him.

Notwithstanding these drawbacks the government headquarter staffs as a body stand well with the public. In Ottawa, the headquarters of the Federal Service, its engineers are leaders in Civil Service councils. The Ottawa Branch of The Institute whose members are largely drawn from the service sees its luncheon addresses attended by members of the Dominion Cabinet, Deputy Ministers of Departments and prominent citizens, its meetings are well reported in the local press. Outside of Ottawa, superintending and district engineers of the Dominion and provincial governments are prominent in their localities. As representatives of the central authority they wield considerable influence and in their dealings with contractors and business men their position is recognized.

Government engineers have occasionally opportunities of attending international gatherings of a technical or diplomatic nature as representatives of their government. They may even take a part in negotiating conventions or treaties with other countries. At these meetings the Canadian representatives profit by the prestige of their country. The work at these conferences may be difficult and entail large responsibilities but it is always most interesting and cannot fail to have educational value besides reflecting honour on the delegates.

In municipal administration the engineering staff have good standing on the list of corporation employees. The heads of the various engineering sections are well known in the community, their work is under the eye of the citizens and they generally enjoy the esteem of the public. The individual members of the staff are well advertised, the daily press, which is very personal, records their professional activities and each one is well known to the public in connection with his work. When the town is under the engineer-manager system this official is the most prominent member of the administration.

At election time the works department of a city is generally a target for criticism and the medium of attack on the civic administration but the engineers are seldom attacked personally. If however anything goes wrong in any of the public works of a city, if any accident occurs, the press and the public are liable to visit their displeasure on the engineering staff and call for the dismissal of the engineer in charge of that branch. A man with an unblemished record of years may thus lose his position as the result of public clamour over an accident which he could not control with ordinary precautions. The same is true in a lesser degree in Dominion and provincial staffs. The result is that the public service engineer has to play safe in design, construction and maintenance, he cannot afford to cut as close as his colleague in commercial practice; while this is desirable if kept within limits it should not be stressed unduly as it leads to unnecessary cost and expenditure of public funds.

An engineer in public service needs to be something of a diplomat, he has to keep on good terms with his numerous employers, the Ministers of the Crown, Members of Parliament or of Legislature, city controllers or aldermen and while maintaining friendly relations with these and other influential persons, and endeavouring to meet their views, the engineer must have as his first object the carrying out of his work with efficiency and to the best of his ability and must not allow himself to be diverted from the straight path by considerations of party politics or of personal preference.

Remuneration

The rates of pay for engineers in public service are as a rule low. In 1929 a commission headed by Mr. E. W. Beatty, president of the Canadian Pacific Railway, investigated the salary scale of the Federal Civil Service. The commission recommended substantial increases to the rates of pay of the engineers. The commission found that pay given to juniors, young men fresh from the university with little or no practical experience was fair enough, but the pay of men with some fifteen or twenty years of service occupying positions of responsibility was decidedly inadequate. The pay of the chiefs was low and this affected the rates paid to all the intermediate classes. The government seemed to concur generally with the report of the commission and was disposed to favour a revision of rates of pay. Unfortunately the country's finances dropped at that time and no action was taken, but when the depression has passed the recommendations of the Beatty Commission may be considered.

Salary rates in provincial governments and city administrations are guided generally by the Dominion government rates and are also low. They are not as a rule so well defined nor do they provide so clearly for periodical increases. They are much more dependent on the decision of the minister or of the board of aldermen. This lends itself to political influence, to wire pulling and to the exercise of political patronage which is a detriment to efficiency in the service.

It is this political patronage which is the chief drawback to the position of the public service engineers. While the engineers with the Dominion government are protected from patronage in their appointments and salary they have to deal with this evil in their handling of contracts and work by day labour. The contractors' political friends are liable to bring pressure on the engineer to influence his judgment and obtain favoured treatment for the contractor. In the case of day labour, if the engineer has any control of the hiring and dismissal of the labour force he is expected to see that friends of the party in power are given preference and may find himself in trouble if men holding opposite views are placed on the pay list.

Engineers with provincial governments and municipalities suffer from these troubles to an even greater degree. The conscientious engineer, striving for economy and efficiency has often great difficulty in steering a course which is safe as well as straight.

Recent events have shown that the positions of engineers in some provincial administrations are held subject to political considerations. If this principle is admitted it destroys the feature of continuity which is advanced as a compensation for the low rates of pay current in government positions.

Engineers of the Defence Forces of Canada

The three arms of the defence forces, the navy, the army and the air force carry engineer officers trained as specialists in their own particular branches.

The permanent forces in Canada are small and are maintained mainly for the training of the non-permanent units and as a nucleus which could be expanded in time of emergency.

The naval engineers specialize as marine engineers. They are responsible for the construction and maintenance of the naval ships, have charge of the repair facilities of the navy yards at Halifax and Esquimalt and of the engine rooms of war vessels and act as consulting engineers to other government departments on questions of ship construction and repair.

The air force engineers are specialists in the construction of aeroplanes and air ships, they are responsible for the inspection and maintenance of the planes of the air force and also act as technical officers for the civil aviation administration, they have charge of the air repair depot at Ottawa and of the technical equipment of the air force.

The engineers of the army permanent force are listed in the Corps of Royal Canadian Engineers who are the construction engineers and the Royal Canadian Corps of Signals which is the electrical section; the mechanical engineers, who are few in numbers, will increase with the growing mechanization of the forces.

The typical officer of the Corps of Royal Canadian Engineers is a graduate of the Royal Military College and a Bachelor of Applied Science of one of the universities, he follows a course of one year at the School of Military Engineering at Chatham and may be attached for a period to the Ordnance Survey in England. As an officer of the permanent force he attends Staff College courses in England and qualifies for his various promotions. He is a highly trained engineering and military officer with his mind broadened by study abroad.

His main occupation as a military officer is training the non-permanent engineering units in military procedure and in their special duties in time of war. He must also enlarge his knowledge as an engineer and acquire practical experience in design and construction work.

Unfortunately his opportunities for carrying out engineering work are very limited. The practice of the Canadian Corps follows the example of the Royal Engineers in England, whose only activity outside of care of military property is the Ordnance Survey of Great Britain. The Canadian officer may serve on the survey staff on topographical survey; or as a district engineer officer he will have charge of repairs and maintenance of armouries, barracks, rifle ranges, fortifications, ordnance buildings and occasionally have some construction of military works. Recently the Engineering Corps has laid out and supervised the work carried out by the relief camps of the Department of National Defence and is performing a remarkably good job of work. The engineering officer has very few opportunities of carrying out any important engineering works, his engineering faculties lie fallow and the country receives little return for the expense of his engineering education.

Various methods have been proposed to remedy this undesirable situation, It has been suggested that officers of the Engineering Corps should be seconded for a few years to a construction department of government or to some of the large contracting firms of the country to give them more intimate knowledge of construction work on large and difficult undertakings conducted with special attention to cost and time, and to acquire experience of estimating cost of work under competitive conditions. While it has not been found practical to carry out these suggestions it may be possible to put them in execution when construction revives and more engineering work is available.

The officers of the Corps of Signals fare better, as the Department of National Defence operates through them a chain of radio stations through the Mackenzie Valley to Dawson and Aklavik. They also installed radio beam stations for the airways across the prairies, these are dormant but may be revived when the trans-Canada airways become operative.

General

In this paper stress has been laid on conditions of Dominion government service and more space has been given to this service. This is because the Dominion government is far ahead of the others in the application of the merit system and of superannuation.

It is probable that a majority of Canadians are in favour of the merit system in government service but attacks are still made on it occasionally by parties who wish to restore political patronage, and these attacks are most to be feared when there is a change of administration. The present conditions of unemployment has intensified the demand on ministers for jobs for party workers.

There is unfortunately no national organization to bring the weight of public opinion to bear against the pressure of political job hunters. Several efforts to organize a public service reform league have failed and such a society is much needed. The Ontario government minister who recently declared that he considered the patronage system the curse of every administration in the country would welcome the support of such an organization to strengthen his hand in his fight against the patronage evil. Engineers should take a part in promoting this movement and in urging the adoption of necessary legislation.

Provincial governments stand to-day in their civil service methods where the Dominion government stood some twenty years ago. They lag behind in the application of the best methods of building up an efficient staff for the administration of the business of the province and therefore cannot attain the best results. Employees who know that their success and advancement depend entirely on their skill and application are keen and anxious to carry out their work with the utmost efficiency, but if they feel their success depends more on political favour than on professional attainments they are liable to become indifferent and not to give that full measure of their ability to which a good employer is entitled. Employees who know that their position is secure and that when their period of usefulness is over there will be a pension for their declining years and provision for their family have minds free from care and are able to concentrate all their faculties on their professional work.

The principle of superannuation is recognized by commercial companies. The banks, the railway companies and many large industrial concerns have effective pension schemes in operation. The Dominion government was early in the field; at the time of confederation it had a superannuation act based on the British act. The act has been amended from time to time and the present act embodies the experience gained in its operation. It has proved a most useful help to good administration.

The trend of modern legislation is towards old age pensions, unemployment insurance, minimum wage requirements and other provisions for the protection of employees. Governments who pass this legislation should set a good example to industry and provide similar protection for their staffs. The drawback to government service is the operation of political patronage. This has been fairly well eliminated from Dominion government service where the merit system is well established. In provincial and municipal governments the patronage evil still prevails and until it is eliminated and the merit system adopted efficient administration will be difficult.

Government service does however present an attractive career for the engineer. It offers great variety of employment, it provides good scope for his ability and enterprise; while salaries are low, continuity of employment is general, and security of tenure is assured, at least in Dominion government departments, together with reasonable retiring allowances.

The government engineer has a dignified position in the community, has opportunity for improvement and advancement, has the satisfaction of taking part in the administration of the country and of advancing the interests and contributing to the welfare of his fellow citizens.

Simple Graphical Solution for Pressure Rise in Pipes and Pump Discharge Lines

Robert W. Angus, M.E.I.C. [1]

DISCUSSION

A. W. F. McQueen, A.M.E.I.C.[2]

This interesting paper has made available not only a useful tool by the aid of which the solution of water hammer problems may be materially expedited but also an elucidation of the work of Allievi.

Water hammer phenomena, thanks to the researches of Joukovsky and Allievi and to many others who have expanded the work of these writers, are susceptible of definite analysis. But, in practice, conditions are usually anything but simple. Pipes are branched or have off-takes, they vary in size and have plates of different thickness at different sections. The forces producing water hammer are also seldom of a uniform nature. All of which makes a computation exceptionally difficult and laborious. Under conditions such as these a graphical solution may often have decided advantages over an arithmetical one.

As far as the writer can discover the work of both Allievi (as translated by Halmos) and the author have been predicated on a horizontal pipe. In an earlier paper by Allievi, the equation $H - H_0 = F + f$, which is the author's equation (6), was developed from an inclined pipe and is given as $H - H_0 = F + f - x \sin \alpha$ where α is the angle which the pipe makes with the horizontal. The writer would like to inquire if the graphical method of the author will apply equally well in this case.

In the section headed "Pump Discharge Lines" where an illustrative problem is being discussed, the author makes the statement "It is, however, unable to do so because a perfect vacuum exists at A 15.2, and yet there is a velocity of 3.86 feet per second toward the reservoir, so that an empty space will form on the reservoir side of the valve and the pressure will remain at absolute zero during the whole of this 3.8-second interval......". The writer wonders how true a picture this is of the phenomena that will obtain for the conditions assumed. When the pressure drops below atmospheric and tends towards absolute zero it seems that the condition known as "cavitation" will take place, i.e., the minute air bubbles always present in any but absolutely pure water will form focal points for the formation of water vapour and the freeing of gases contained in the water. So that, instead of having an "empty space" there will be a fluid composed of water, water vapour and gases the elastic properties of which will be sufficiently different from water as to render necessary a change in the physical constants employed.

If a word of criticism may be permitted, it is to be regretted that the author did not adhere wholly to the recommended symbols as published by the American Society of Mechanical Engineers in their Water Hammer Symposium. For instance the Greek letter ψ, for the author's G, is not only the recommended standard of the above mentioned body but has been used by Allievi to designate the ratio between the effective variable gate opening and the area of the pipe throughout his work.

S. Logan Kerr, M.E.I.C.[3]

Professor Angus has done the engineers of Canada and the United States a great service in presenting at this time these most interesting developments in the solution of water hammer problems. The general concept of graphical solutions was set forth by Professor Allievi in his classic work on this subject. Several more recent studies by engineers in Germany, Switzerland and France have improved upon the technique, and have forged a most efficient weapon with which to attack the complexity of the usual water hammer investigation.

The laborious formulae of Allievi and others, simplified by Mr. Norman R. Gibson in his "arithmetic integration method" were improved upon still further by Mr. Ray S. Quick in his paper before the American Society of Mechanical Engineers in 1927* and have been the bases of most water hammer studies. The simple problems which involve only a uniform conduit and a uniform rate of velocity extinction can be solved readily as far as the maximum surge is concerned by using one of the charts prepared by Professor Allievi or Mr. Quick. The complex problems that must take into consideration the shape of the curve of pressure with respect to time, or which concern conduits that are of different thicknesses, materials or diameters, or in which the flow is cut off at variable rates, these problems require long calculations and much time and skill in their solution.

The graphical method at once cuts through much of this cloud of detail and presents an elegant solution that is simple and straightforward in its application. This new tool has permitted the exact solution of problems involving surge chambers and air reservoirs which could only be approximated by any other method.

Still further work has been done in the amplification of the graphical method for surge problems by Dr. Schnyder of Switzerland and Professor Bergeron of France. Among others, the case of water hammer in pump discharge conduits has been brought to the fore by the use of motor

[1] Paper presented before the General Professional Meeting of The Institute, Toronto, February 7th and 8th, 1935, and published in the February 1935 issue of The Journal.

[2] 2250 Dawlish Avenue, Niagara Falls, Ont.

[3] Research engineer, I. P. Morris Division, Baldwin-Southwark Corporation, Philadelphia, Pa.; Chairman Committee on Water Hammer, American Society of Mechanical Engineers.

* Comparison and Limitations of Various Water Hammer Theories Ray S. Quick, Mechanical Engineering, Mid May, 1927.

driven centrifugal pumps and automatic check valves, but even this most involved and difficult investigation can be simplified greatly by the use of the graphical method. In the recent studies which the writer has been making on the application of surge relief devices to pump discharge lines, the graphical method has been invaluable in reducing the time required for the analysis, and in avoiding the confusion that might easily result from some minor error in the laborious computations by the "arithmetic integration method."

It was gratifying to find that Professor Angus has followed with few exceptions the generally accepted symbols of the A.S.M.E. Committee on Water Hammer. These were prepared for the Symposium held in 1933 in an endeavour to avoid the confusion which has been all too prevalent among writers on this subject. It seemed as each author took up his task that he searched out new and unused symbols, usually drawing quite heavily upon the Greek alphabet. There seemed to be no urge for uniformity, and it was quite difficult for the ordinary engineer to compare the expressions and formulae of two or more authors for this reason. It would have, perhaps, been a contribution toward standardization if Professor Angus had retained Mr. Gibson's expression for the index of gate opening B instead of introducing a new symbol G, and the nomenclature of Messrs. Billings, Dodkin, Knapp and Santos, in their excellent paper on "High Head Penstock Design"* for the head and velocity ratio seems to have a greater significance by using h_{xt} and v_{xt} respectively rather than X and Y.

The graphical method offers the most convenient method for investigating the importance of the initial gate or velocity condition from which closure starts. This question was emphasized by Allievi in one of his charts, and studied by Compte de Sparre in France. It was the subject of many researches by Camichel, Eydoux and Gariel in their work on water hammer, parts of which were presented in English by the writer recently.† Too much emphasis can not be placed upon this phase of water hammer, as the usual calculation deals with the cutting off of maximum flow, while the most dangerous surge can generally be produced by cutting off only a small fraction of this flow at a proportional rate.

In the problem cited by Professor Angus, in Fig. 6, the writer has prepared a simplified chart that illustrates the surge intensity that would result from cutting off fractional flows in proportional times, each case considering the closures from some partial opening to zero. The charts (Fig. 14) *d*, *e*, *f*, show the surges resulting from the closures from 80 per cent opening to zero in 80 per cent of the time for full gate closure, 60 per cent gate opening to zero in 60 per cent of time, and 40 per cent to zero in 40 per cent of time respectively. It is interesting to note that the closure from 40 per cent gate to zero is made in exactly the critical period of the pipe line, that is $2\ l/a$ seconds. The pressure rise is far greater than would be the case for full gate closure, and thus might produce a very dangerous condition, particularly in cases where branch pipes or compound conduits are encountered.

In considering the closures from greater values of gate opening, and hence greater discharges than the one considered by Professor Angus, another interesting relation is found, namely, that greater flows can be cut off in proportionally greater times without increasing the maximum surge by any significant amount. The following table gives the ressult of this investigation.

Table I

	Percent Quantity	Percent Time	From Charts Percent Pressure Rise	From Graphical Method Percent Pressure Rise
a	400	400	56.3	55.5
b	200	200	56.5	56.6
c	100	100	61.9	63.0
d	80	80	68.3	67.5
e	60	60	76.0	76.5
f	40	40	90.0	90.0

It may be noted that the maximum surge for this conduit is nearly 50 per cent greater than the apparent surge based on Fig. 6 of Professor Angus' paper.

In following Professor Angus' exposition of the graphical method, attention must be directed toward the function ρ or K as the writer prefers to call it. In fixing 2ρ as the slope, the value of ρ corresponding to the value of v at $E = 1.0$ must always be used, hence, the slope will vary with each different value of initial flow.

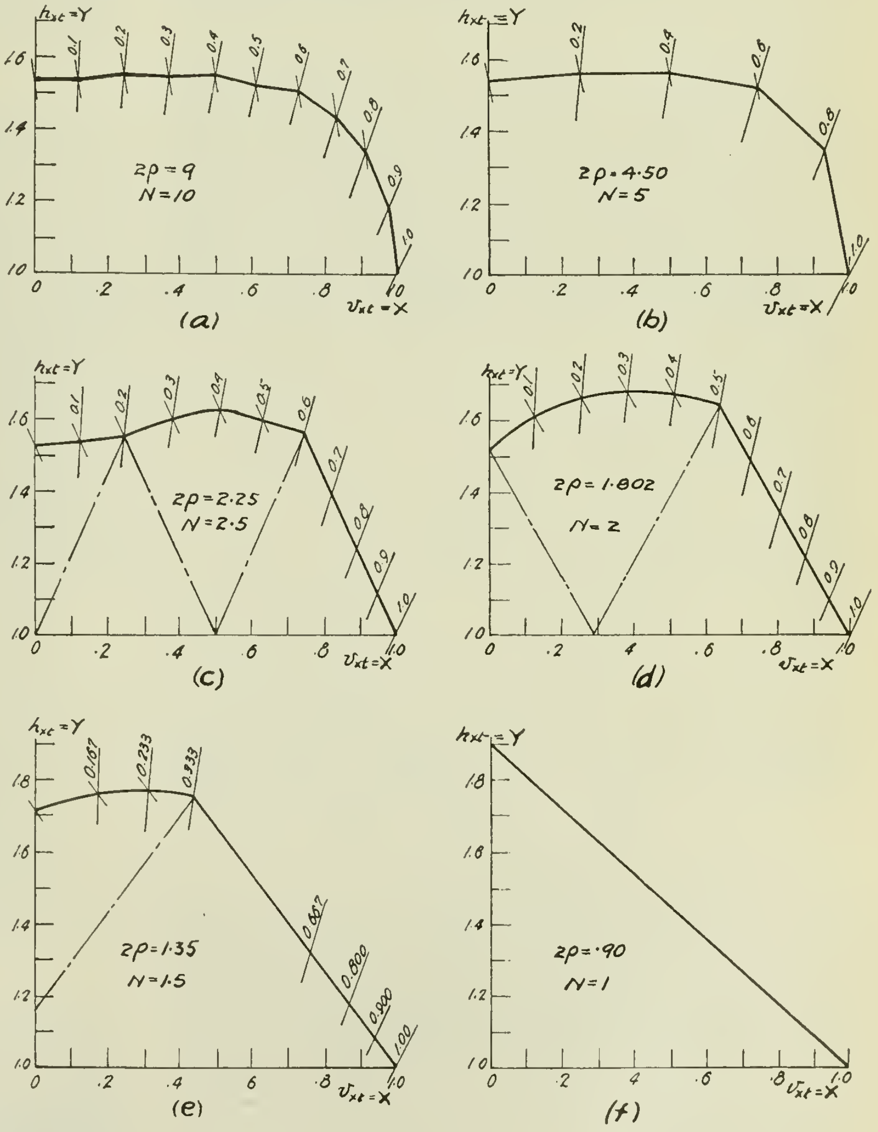

Fig. 14

* Am. Soc. Mech. Engrs., Symposium on Water Hammer, 1933.
† New Aspects of Maximum Pressure Rise in Closed Conduits, Am. Soc. Mech. Engrs., Annual Meeting, 1928.

In other studies it has been customary to use the value of ρ for the maximum conditions, and use a constant slope, and adjust the value of X or E accordingly. Great care must be exercised to use the correct values of these ratios, or serious errors will result.

In conclusion, the writer has compared the results of the graphical method with the solutions by the more usual means (Table I) and has found in every case that the check is exceedingly close. This is not surprising, for the basic formulae are the same and the solutions, therefore, should be the same. The graphical method deserves the careful study of every engineer concerned with water hammer problems, and while it is a longer method than the solution of the charts for uniformly retarded water columns in simple conduits, it is a great simplification for many of the more involved problems encountered in actual practice.

The activities of the Water Hammer Committee of the American Society of Mechanical Engineers are being continued as a semi-permanent committee under the Hydraulic Division of that Society. A second Symposium on Water Hammer is being planned for 1936, and special arrangements have been made whereby associate members have been designated from certain foreign countries to assist the A.S.M.E. in their programme, and it is hoped that The Engineering Institute of Canada will feel free to co-operate with this work so that two members of their Society can be designated as the associate members of the Committee for Canada.

E. B. Strowger[4]

Professor Angus has presented the graphical method of water hammer computation in a manner which makes it quite simple, and the numerous applications given add to the usefulness of the paper. He first develops the pressure wave curves for a simple pipe by referring to Joukovsky and to the "arithmetic integration" method of computing, published by N. R. Gibson, and then introduces the Allievi equations by considering the summation of the upward travelling direct waves and the downward travelling indirect

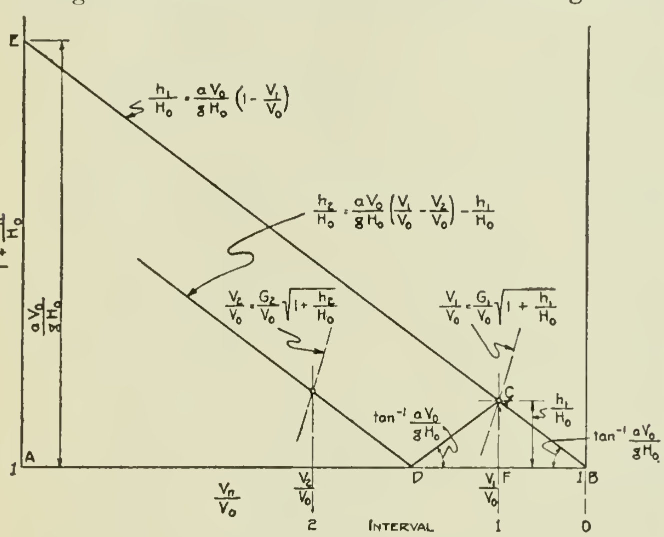

Fig. 15

waves. The method of simultaneous equations is then developed and the graphical method, of course, follows. This is a logical method of development and it is interesting to find that the arithmetic integration computations are used in developing the proper concepts of the problem. The speaker has taken exactly the same method in analyzing the five Allievi equations given in Mr. Halmos' abstract of the 1902 Allievi paper before finally deriving them by a rigorous method.*

[4] Buffalo, Niagara and Eastern Power Corporation, Buffalo, N.Y.

The writer wishes to call attention to some pioneering work done on the subject which may have been overlooked since it was not published as a complete paper in itself. In July 1926 F. M. Wood, of the Civil Engineering Department of McGill University, introduced a graphical method in his discussion of the A.S.M.E. paper† entitled "Speed Changes of Hydraulic Turbines for Sudden Changes of Load" written jointly by S. L. Kerr and the writer. Wood's method is based upon the Gibson equations for water hammer which have been shown to agree exactly

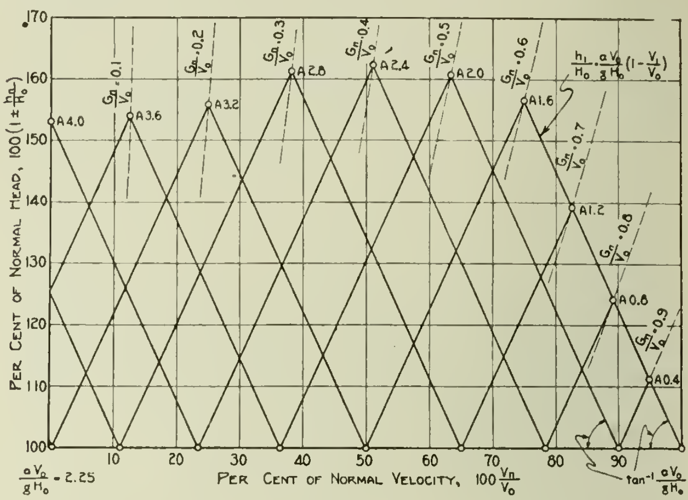

Fig. 16

with the Allievi equations. Basically Wood's graphical method is identical to that given in the Angus paper, as may be seen from the development of the Wood chart given later on. About the same time that Wood published his graphical method Mr. H. Kreitner‡ published in German an account of the graphical method based upon the Allievi equations. His work was described by Loewy in the latter's book on water hammer, to which Professor Angus refers, and was used by Professor Bergeron in his 1931 paper and by Professor Angus in the paper at hand. Both Wood and Kreitner were, to the writer's knowledge, the originators of the graphical method of solution and deserve mention.

Wood has taken the formulae of N. R. Gibson and arranged them to form for each interval two simultaneous equations which lend themselves to a graphical solution. These are for the first interval

$$\frac{v_1}{v_0} = \frac{G_1}{v_0}\sqrt{1 + \frac{h_1}{H_0}}$$

$$\frac{h_1}{H_0} = \frac{av_0}{gH_0}\left(1 - \frac{v_1}{v_0}\right)$$

for the second interval

$$\frac{v_2}{v_0} = \frac{G_2}{v_0}\sqrt{1 + \frac{h_2}{H_0}}$$

$$\frac{h_2}{H_0} = \frac{av_0}{gH_0}\left(\frac{v_1}{v_0} - \frac{v_2}{v_0}\right) - \frac{h_1}{H_0}$$

and for the nth interval

$$\frac{v_n}{v_0} = \frac{G_n}{v_0}\sqrt{1 + \frac{h_n}{H_0}} \quad \ldots\ldots (23)$$

$$\frac{h_n}{H_0} = \frac{av_0}{gH_0}\left(\frac{v_{n-1}}{v_0} - \frac{v_n}{v_0}\right) - \frac{h_{n-1}}{H_0} \quad \ldots\ldots (24)$$

* See discussion No. 5 A.S.M.E. Symposium on Water Hammer, page 133.

† Trans. A.S.M.E. Vol. 48, page 243.

‡ Druckschwankungen in Turbinenrohrleitungen, Die Wasserwirkschaft, 1926, No. 10.

where the symbols used correspond to those of Professor Angus. The first of the two simultaneous equations when plotted gives a family of parabolic curves and the second a family of straight lines. Referring to Fig. 15 the point C, the intersection of the first line with the first parabola gives the head and velocity values at the end of the first interval. A line drawn through C with a slope of $\frac{av_0}{gH_0}$ intersects the axis at D. A line drawn through D parallel to BC represents the straight line for the second interval, etc. It should be noted that the distance AE on the Y axis is equal to $\frac{av_0}{gH_0}$ or 2ρ, this being the Y intercept of the straight line equation for the first interval considering the origin of coordinates to be at A. The point D may be located, without drawing the line CD, by laying off FD equal to BF and then drawing the line through D parallel to CB.

The quantity G may be determined from the relation between gate opening and velocity for the particular device, such as the turbine, under consideration. This relationship is usually assumed to be a straight line but it may be based upon one of the characteristic curves of the turbine. Figure 16 gives the Wood chart for the example given by the author in his Fig. 6. Uniform variation of velocity with respect to gate opening is assumed. The result is seen to be identical to that given by the author

It should be noted that by substituting $(h_n + H_0)$ for H_n, equation (24) given above may readily be derived from

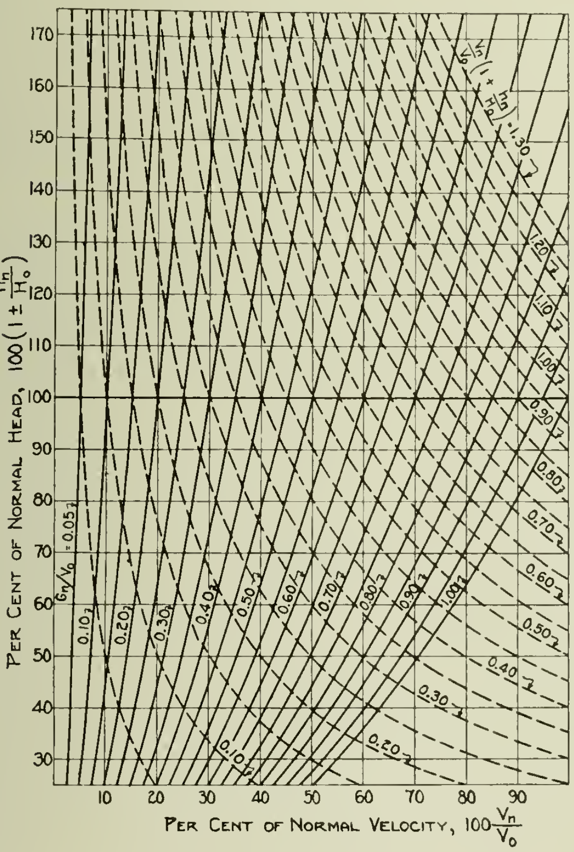

Fig. 17

equation 8 of the paper, showing that the chart given by Professor Angus is essentially the same as that given by Wood.

Figure 17 presents a general chart which the writer has used for facilitating the graphical determination of pressure rise or pressure drop problems in connection with the usual hydroelectric turbine installation. By drawing on the chart light lines with the proper slope and intersecting with the proper set of parabolas, interpolated if necessary between the ones given, the pressure curve can be obtained. This chart was made for general application and can be used with any gate discharge characteristic obtaining with a particular type of runner. The chart has been extended below the point of normal head to cover the field of pressure drop and curves for $\frac{v_n}{v_0}\left(1+\frac{h_n}{H_0}\right)$ have been included to facilitate speed rise computations. For this purpose the values of this product adjusted for part gate efficiency determine the horsepower input to the turbine at the end of each interval and thus when integrated over the time of gate closure give the energy producing excess speed in the rotating parts of the turbine and generator.

These charts for solving the water hammer problem involving the simple type of hydroelectric layout are shown here primarily for the purpose of calling attention to the origin of the graphical method. Professor Angus has succeeded in extending the application of the method beyond the simple case to many problems which, without the chart method, would be very intricate, and in so doing he has added considerably to the simplification of this subject.

F. M. Wood, A.M.E.I.C.[5]

This paper in its application of graphical methods to the study of pressure rise problems is of distinct value to the hydraulic engineer. The study of resonance conditions in particular, is greatly simplified, and evidently there are many other allied problems to which the method may be applied.

An article entitled "Speed Changes of Hydraulic Turbines for Sudden Change of Load" by Mr. E. B. Strowger and Mr. Logan Kerr, was presented before the American Society of Mechanical Engineers at their spring meeting in 1926. In a discussion of this paper the writer developed a similar graphical method for the solution of the pressure rise equation. The method was applied particularly to speed changes in hydraulic turbines, but the fundamental nature of the charts is the same in both cases. This agreement is necessarily due to the fact that both are the graphical equivalents of the same algebraic equations.

The accuracy of the graphical method is dependent on the correct position of the intersecting lines, and on the correct determination of points of intersection. In cases where the quantity ρ is large, great accuracy is not to be expected. This, however, should not deter one from the use of this method when one considers its simplicity, clarity and rapidity.

F. Knapp[6]

The author is to be commended for his effort to bring the graphical method of determining pressure rises to the attention of a greater circle of engineers. However, it would have been better if he had adopted the symbols for water hammer formulae recommended by the A.S.M.E. Committee on Water Hammer.

A reader without detailed knowledge of the surge theory would be inclined to consider Dr. Schnyder's approximate method of taking friction into account, as shown by Fig. 13, to be of the same degree of accuracy as the simultaneous or conjugated equations 13 and 16. This is not the case.

The method of taking friction into account as shown by Figs. 11 and 13 assumes that the friction losses are concentrated at the intake. A closer study of the Y-X diagram

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[6] Assistant hydraulic engineer, The Sao Paulo Tramway Light and Power Company Ltd., Sao Paulo, Brazil.

indicates that this method over-estimates the influence of head losses. This view is confirmed by tests. More accurate results are obtained by assuming that only a certain percentage of the friction loss is concentrated at the intake. This percentage is not constant, but varies with time of closure and characteristics of the pipeline and so must be estimated in each case. A computer without actual experience and not guided by test results most likely will not make the correct assumption. Reliable results may be obtained independently of such assumptions, if the total friction loss is divided into parts and each part assumed as concentrated at several intermediate sections of the line. The necessary changes in the *Y-X* diagram are apparent and need not be discussed here. It may be mentioned, however, that the paper would have gained in clearness by emphasizing the "end-conditions," e.g., the pressure and velocity conditions at the two ends of a pipe section with constant characteristics. This notion of end conditions, together with combined sets of equations similar to equations 13 and 16, permits extending the graphical method to more complicated cases as, for example, bifurcated pipelines. The present status of the water hammer theory permits pressure rises in complicated water works distribution systems to be computed with but little effort. Actual practice has shown, that from the point of view of decreasing the magnitude of surges, and hence increasing safety of operation, the design of such systems may be improved.

The question of the influence of head losses as far as water hammer is concerned, might appear to be of academic interest only inasmuch as it scarcely needs to be considered for the computation of ordinary surges in turbine penstocks. But as soon as exceptional or emergency conditions are considered, neglect of this influence may lead to entirely incorrect results. In such cases, the question becomes of outstanding economical importance.

The author discusses the surge problem from the following point of view: "What is the maximum surge in a penstock of known characteristics caused by an assumed gate movement?" From the point of view of the designer, however, the important question is: "What should be the characteristics of a pipeline designed to resist an assumed accidental surge condition with minimum annual total charges?" The exact meaning of this question will become clear from the following.

In the paper "High Head Penstock Design" by A. W. K. Billings, O. H. Dodkin, F. Knapp and A. Santos Jr., a turbine penstock with diameters increasing towards the powerhouse was proposed. The characteristics of this design were such that at the changes of diameters the "transmission-coefficient" was equal to unity. Compared with a penstock tapered in the usual way, the suggested "inverse taper" design promised considerable savings. However, the comparison is incomplete to the extent that friction losses were neglected and also because the diameters and lengths of each section of the "orthodox taper" design adopted as a basis had been arbitrarily selected. Of course, the two designs had equal friction losses for the weighted average discharge and were also designed for exactly the same exceptional or emergency condition.

	Maximum pressure rise in the third positive interval in percent of Joukovsky's surge	Difference in percent
Neglecting friction	111	+19.7
Test result*	93	0
With 100 per cent of friction concentrated at intake	74	−19.1
Ditto with 50 per cent	85	− 7.9
Friction concentrated in five sections of penstock	93	0

* Courtesy of Mr. H. L. Doolittle, Chief Designing Engineer, Southern California Edison Power Co.

The preceding table of nearly instantaneous pressure rises for a two-diameter penstock, tapered in the usual way and in which the head loss amounts to only 0.45 per cent of the static head, shows the influence of friction in such an exceptional case.

Thus under certain conditions the maximum pressure rises in an orthodox taper penstock are not far greater, or may even be smaller than the absolute minimum Joukovsky surge.

For this reason the conditions which would cause minimum pressure rises under very quick closure were investigated, and it was found that equal reflection times and equal transmission coefficients were necessary requirements. The table below compares the maximum water hammer in an orthodox taper three-diameter penstock, having equal reflection times computed without taking friction losses into account.

Transmission Coefficient	Maximum surge in percent of Joukovsky's surge
1.0	100
0.98	144
0.96	162 (absolute maximum)
0.90	153
0.80	141
0.70	132
0.50	119
0.25	107
0	100

As already stated, friction losses reduce these maximum surges to a greater or lesser extent, depending on conditions. For example, with friction losses amounting to 2 per cent of the static head and with a transmission coefficient of 0.80, the maximum surge is equal to the Joukovsky value and the rise in the third positive interval attains only a value of 96, instead of 141 per cent without friction.

Thus, it is seen that instead of the inverse taper penstock with its several disadvantages, a pipeline with the usual taper and judiciously chosen characteristics, may be designed to resist more economically any accidental water hammer.

In this connection it is interesting to refer to the test results published in the paper already mentioned and which showed maximum surges of 172 per cent of the Joukovsky value†. The good agreement between test and computation obtained without taking into account the head losses is due to the fact that the tests were carried out on a full-size penstock, shutting off exceedingly small water quantities.

It is unlikely that modern and properly designed governors will be so carelessly adjusted as to hunt in such a way as to cause the gate movements shown in Fig. 10. Cases are known where, due to lack of maintenance, the linkage system of double governors with needle and deflector, had so much play as to cause hunting movements, which were, however, of far smaller magnitude than those shown in this figure.

Experience has shown that resonance between load variations and the natural pressure oscillations in the penstock may produce surges which are considerably greater than those caused by shutting off the unit. In the Spullersee high head plant of the Austrian Federal Railways resonant surge action was repeatedly observed which resulted in water hammer of about 300 per cent of that caused by closing the turbine normally. Gate movements as shown by Fig. 9 may be produced by hand operation but never by a governor under automatic control.

Some remarks as to the historical development of the method discussed by the author may be of interest. The basis of this graphical method was first developed by Mr. F. M. Wood of McGill University, Montreal, although he did not recognize the full importance and the pos-

† See Symposium on Water Hammer, page 58, figure 8.

sibility of extension of his method. In 1928, Dr. Loewy of Vienna, Austria, independently developed the same method, which is, however, only applicable for the computation of pressure rises at the gate. Loewy's proposal for computation of surges at intermediate sections of a simple penstock is erroneous. The first published account of the method as discussed by the author together with the important simultaneous equations appeared in 1932 by Dr. Schnyder of Klus, Switzerland, and is the basis for a general graphical method for computation of water hammer not only in simple, but also complex and compound conduits with end-conditions determined by reaction or Pelton turbines, pumps, reservoirs, surge tanks or valves at intermediate sections.

A. Santos, Jr.[7]

The author's paper consists of the presentation of part of the existing knowledge of water hammer. It does not add to our knowledge of the subject, as no new problems are solved and no new methods are introduced. Notwithstanding, it has commendable features, one of which is the clarity imparted by the several numerical examples.

Regarding Allievi's writings on the subject of water hammer, the author did not make it sufficiently clear that Halmos translated into English only "Allievi's Additional Notes," but not his original paper.

There is room for considerable divergence of opinion as to whether the Notes contain too much mathematics. Neglecting the abstract of Allievi's original paper, which precedes the Notes and which contains certain partial differential equations from hydrodynamics, the rest of the work involves only the use of algebra. Perhaps the reason why Allievi's writings are not much read by engineers is to be found in the fact that his conclusions, formulae and diagrams lack general applicability, inasmuch as they are all based on the assumptions of uniform diameter and thickness of the pipes. Most of them are also based on the further assumption of linear closure of the gates. These conditions hardly ever obtain in actual commercial installations.

With respect to the paper by Miss O. Simin, cited by the author, it is to be noted that "it involves no original research" on water hammer, and is "merely a compilation of existing information respecting this subject, including especially a digest of the notable work of Professor N. Joukovsky, at Moscow..."

From Fig. 5 of the author's paper it is not clear how to determine the starting point of the inclined lines representing equations (20) and (21). If friction is neglected these lines always start from the intersection of the horizontal line $Y = 1$ with the parabola representing the gate opening at the beginning of the disturbance or gate motion.

Of course the conditions assumed for the interesting example shown in Fig. 9 could never be observed in a hydraulic turbine installation under automatic governor control. In such a practical case the generating unit would be synchronized, with the valve at the "speed-no-load" position, before any further opening of the valve could take place. In commercial installations a valve can be made to go from the fully closed to the fully open position and then closed again entirely, only if this be deliberately done by hand.

The method shown in Fig. 11 for solving surge tank problems is instructive but lacks somewhat in accuracy, owing to the assumption of friction losses totally concentrated at the intake. Further, the smallness of the angles of intersection of the lines is not conducive to precision. Surge tank problems of this kind can be more expeditiously and more accurately solved by the diagrams given by Calame and Gaden in their book "Théorie des Chambres d'Equilibre."

[7] Assistant hydraulic engineer, The Sao Paulo Tramway Light and Power Company Ltd., Sao Paulo, Brazil.

J. B. Macphail, A.M.E.I.C.[8]

The author, in the second paragraph of his paper, is properly enthusiastic about the work of Allievi, but appears to be unfamiliar with an excellent historical account by Professor R. Neeser, of the University of Lausanne, which is sufficiently authoritative to warrant some correction of, and addition to, that paragraph.

In 1903 Allievi published a monograph, not a book, in Italian: and in 1904 he published a French translation of it in the Revue de Mécanique. A German translation was published by Dubs and Bataillard in 1909.

This monograph, as Allievi himself has said, was merely the mathematical tool and not the theory, but in 1913 he published in Italian his "Theory of Water Hammer, Notes I to V."

A French translation of Notes I and II, together with a summary of the original monograph and a preface containing a good historical account of the subject and an appreciation of the work of Allievi was presented by Neeser in the Revue de Mécanique in 1914, but publication of the subsequent notes was stopped by the war. In 1921 Daniel Gaden republished in French in Paris in book form this work of Neeser, adding thereto his own translation of Notes III, IV and V. The foregoing information comes from this French text. The English book prepared by Mr. Halmos in 1925 contains a translation of Notes I to V and a translation of Neeser's summary of the original monograph, together with a part only of the Neeser preface.

Quoting this preface, the oscillatory character of water hammer had been recognized long before then by M. J. Michaud in 1878, among others, as being due to the elasticity of the conduit and the compressibility of the water; but "all the authors who preceded Allievi believed this influence could be introduced in the calculations by supposing the elasticity of the walls and of the liquid to be concentrated, so to speak, at a determinate point of the conduit in the form of an elastic reservoir of suitable capacity." Accordingly Allievi "disregarding the paths broken by his predecessors...commenced by systematically and voluntarily ignoring all that had been done before." This seems to be a great deal more than having merely "simplified the work previously done" according to Professor Angus.

It is agreed that Joukovsky made extensive experiments in Moscow in 1898, but only in the limited field of valve closures which were practically instantaneous; and that he established the relation that the maximum pressure rise following such a closure is av_0/g, which incidentally is not quite equation (1).

Does not the author then do him too much honour in attributing to him the place of having "established the general theory and certain fundamental equations" of the complicated problem defined in the first paragraph of the paper?

Figure 1 shows a conduit having a portion of its length inclined, and a warning should be given that page X of the Halmos translation supposes the conduit to be horizontal. True, some of the equations can be applied to inclined pipes, but others, particularly those dealing with head-ratios, cannot.

The notation is not consistent. For example, the symbol H is defined as the head close to the gate, whereas in equations (6) and (7) it is correctly used for the head at a distance x from the gate, in a transcription of equations V on page IX of Halmos. In equation (8) however, which is a transcription of equations (6) on page 6 of Halmos, the symbol H_n must refer to the gate. Also the suffix A is defined as applying to the gate, whereas in Fig. 3 it applies to some other place. Again, in the development beginning

[8] Power Engineering Company Ltd., Montreal.

with equation (12) there are several cases where H_{At1} and similar symbols are used, whereas H_{At_1}, is actually meant. Also there are four different equations with the number (20), and several other cases of duplication. For clearness, equations (18) might perhaps have been given the numbers (17) because they come from equation (13). Equations (17) would then bear the numbers (18) because they come from equation (16), and they also refer to the reflected wave, Fig. 4b. The subscript t at first refers to the larger of two times and a little later to the lesser. A warning might be added, to the paragraph following equations (17) and (18), that the equations can not be used to get the waves past the section where the pipe characteristic changes, because certain wave reflections occur at this section.

These difficulties of notation are not very serious, but they obscure the argument in a difficult subject; and delay the reader because it usually takes a little time, first to decide that some notation is wrong and then to infer what the author meant to say.

However, once past these troubles, the method seems very attractive, particularly because of the speed with which it can be applied. A full understanding of the principles, and of the difficulties involved can be obtained only by working through a number of examples. Some question may be raised about the accuracy obtainable, but it can be answered by remarking that the method is probably better than the knowledge of the physical data requires. And at the worst it will be useful in indicating what maximum conditions should be examined in more detail.

Concerning the surge tank problem, something might properly have been done to show why equation (8) is applicable to circumstances so different from those for which it was derived. It will further be recalled that the customary differential equations for designing surge tanks give very satisfactory results, though their derivation involves assumptions from which can be derived a value of $a = \infty$. There is good reason for believing that the value

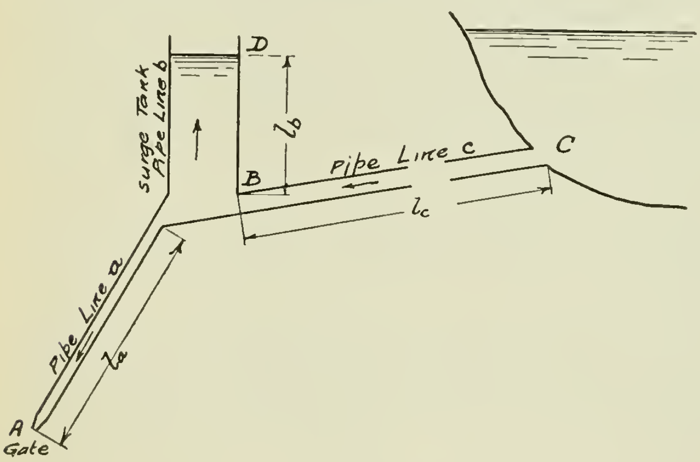

Fig. 18

of a should enter surge tank calculations, but the equations should be such that substitution of the value $a = \infty$ leads to determinate results which, in many cases, have been very satisfactorily confirmed by tests. The terms containing a would be expected to be of relatively small order, and neglecting them might be considered to involve the same errors as in those cases where second differentials are properly discarded. It would be interesting to test equation (8) with three different values of a in some simple case to see if there is some approach to a limit, and to compare that limit with the result given by Jakobsen's rapid method of arithmetic integration.

Dr. O. Schnyder[9]

Professor Angus has developed a graphical method for the determination of water hammer pressures in pipe lines and has demonstrated, by means of very interesting examples, the breadth of its application.

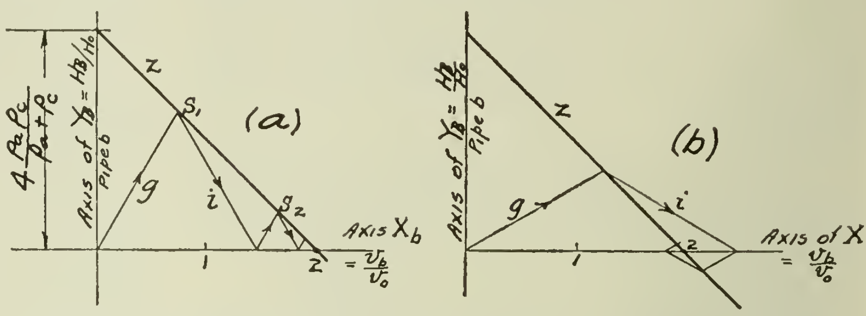

Fig. 19—Water Hammer at Surge Tank for Instantaneous Gate Closure.

The advantage of the graphical method lies in the fact that it is possible to establish, without much additional work, the pressure conditions at any point in a pipe line. Furthermore, this method gives full information as to the changes of velocity that occur. This is of great importance, and as one example the case of the closing devices on pipe lines may be mentioned. These devices are used to protect pipes which are endangered by an extremely large flow of water due to accidental failure of the pipe; they go into operation as soon as the pipe velocity exceeds that corresponding to maximum demand for power or other normal service. The pressure-velocity diagram shows when the velocity exceeds the normal value at the inlet end, due to sudden load demand, and the flow may be further augmented by the opening of the relief valves, caused by resonant movement of the turbine gates. The extent of this increase is important in the regulation of the above mentioned closing devices if they are not to produce bad conditions on the pipe and if the danger of an undesirable rate of closure is to be avoided.

Moreover, the knowledge of the dynamical variations of the velocity is desirable in the case of a pressure pipe line protected by a differential velocity device, i.e., by a mechanism which measures the mass of water at the inlet and outlet of the pipe line, and which effects the closure of the inlet gate if a certain difference exists.

The author has also given us an original presentation of the conditions in a surge tank, and for such a study the graphical method is an excellent one, and its possibilities of application are very large.

The writer wishes to enlarge further on this case and will limit his consideration to a surge tank of uniform area, as shown in Fig. 18, consideration being given to the conditions in the tank resulting from water hammer following quickly after the operation of the gate.

For the point B the following relations are true

$$Y_{Ba} = Y_{Bb} = Y_{Bc} = Y_B \quad \text{(25)}$$

$$X_{Bc} = X_{Ba} + X_{Bb} \quad \text{(26)}$$

again $$Y_{Bat} - Y_{At1} = 2\,\rho_a\,(X_{Bat} - X_{At1}) \quad \text{(27)}$$

and $$Y_{Bct} - Y_{Ct3} = -\,2\,\rho_c\,(X_{Bct} - X_{Ct3}) \quad \text{(28)}$$

adding (27) and (28) gives

$$Y_{Bt}\left(\frac{1}{2\,\rho_a} + \frac{1}{2\,\rho_c}\right) - \frac{Y_{At1}}{2\,\rho_a} - \frac{Y_{Ct3}}{2\,\rho_c} = -\,X_{Bbt} - X_{At1} + X_{Ct3} \quad \text{(29)}$$

[9] Société des Usines de Louis de Roll, Klus, Switzerland.

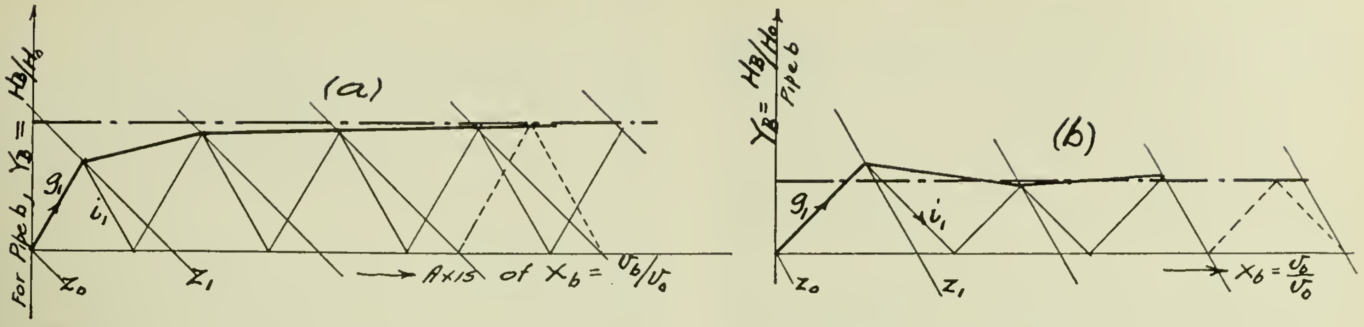

Fig. 20—Water Hammer at Surge Tank for Straight Line Gate Closure.

This equation gives a relation between Y_B and X_{Bb} since the values of Y_{At1}, Y_{Ct3}, X_{At1} and X_{Ct3} are known from other considerations.

The equation evidently represents the hydraulic condition for the surge tank at B and is therefore of fundamental importance for the study of events in the surge tank. On the graphical diagram, this equation is represented by a series of straight lines and the latter may easily be related to the water hammer lines corresponding to equations (27) and (28) by subtracting the values of X_{Ba} from X_{Bc} at the same value of the ordinate, as shown by equation (25)

$$X_{Bb} = X_{Bc} - X_{Ba}$$

Equation (29) represents a series of "limit lines" which are straight and parallel and spaced to suit the time interval, and their application to selected cases will now be made.

(1) *Sudden closure of the gate at A.* In this case,

if $t < \frac{3\,l_a}{a_a}$ the values are $X_{Ct3} = 1$; $Y_{Ct3} = 0$*

$$X_{At1} = 0 \quad \text{and} \quad Y_{At1} = 2\,\rho_a{}^*$$

so that (29) gives

$$Y_{Bt} = (2 - X_{Bbt})\left(\frac{2\,\rho_a\,\rho_c}{\rho_a + \rho_c}\right)^* \ldots\ldots\ldots (30)$$

this equation being represented on Fig. 19 by the straight line Z.

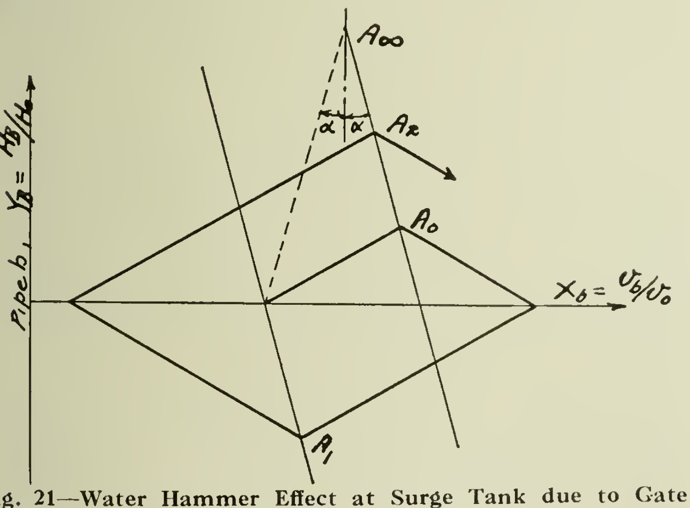

Fig. 21—Water Hammer Effect at Surge Tank due to Gate Swinging Continually, Each Swing Taking $\frac{2\,l_b}{a_b}$ sec.

The water hammer lines for the surge tank will have the equations

$$Y_{Bt} - Y_{Dt2} = 2\,\rho_b\,(X_{Bbt} - X_{Dt2}) \qquad \text{for (g)}$$

and

$$Y_{Dt} - Y_{Bt4} = -\,2\,\rho_b\,(X_{Dt} - X_{Bt4}) \qquad \text{for (i)}$$

At the time $t \leq \frac{l_a}{a_a}$ if no account is taken of the change of water level, $Y_D = 0$* and $X_{Dbt} = 0$ and this locates the first line g and the point S gives the water hammer at B in the tank. The impacts die away periodically or aperiodically, according to the value of

$$\frac{2\,\rho_a\,\rho_c}{\rho_a + \rho_c}$$

as shown in Fig. 19 (a) and (b).

(2) *Linear valve closure.* If gate closure is at uniform rate, often referred to as straight line closure, the results will be as shown on Fig. 20 (a) and (b). In this type of closure, and taking the time interval as $t = \frac{2\,l_b}{a_b}$ the "limit lines" Z are equally spaced, and as this spacing is easily determined, it will not be discussed further.

The relative slopes of the "limit lines" and water hammer lines determine whether the pressures are aperiodic as in Fig. 20 (a) or periodic as in Fig. 20 (b).

(3) *Rhythmic movements of the gate with a time of oscillation*

$$t = \frac{2\,l_b}{a_b}$$

This case is shown in Fig. 21, the lines Z_1 and Z_2 representing in alternate order the conditions at the base of the tank, and to these the water hammer lines have been drawn as shown. If the water hammer lines have a smaller slope than the "limit lines" the pressure oscillations will increase up to a certain value $A\infty$, but for the opposite case these oscillations die away.

The graphical method is applicable not only to pipe lines with surge tanks, but also for any branched piping system. Unfortunately, lack of space prevents the discussion of this matter.

M. Barry Watson, A.M.E.I.C.[10]

The author has stated that the variations of pressure could be found for any particular point on the pipe desired. Does the maximum pressure always occur at the gate, or might it be at some other point further up? If so, does this method lend itself to a determination of that point, so that the pipe designer may calculate the allowable thicknesses of pipe.

E. W. Dill, S.E.I.C.[11]

In view of the reference Mr. Kerr has made as to the variation in pressure changes due to thickness of pipe, would the author say whether the elasticity of the pipe material comes into this question at all? That is, if all steel or concrete.

Professor R. W. Angus, M.E.I.C.[12]

The nature of the discussion shows that the paper has dealt with a subject of live interest, and the author thanks all those who have presented constructive criticism.

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*See author's closure—page 273.

[10] Consulting Engineer, Toronto, Ontario.
[11] British American Oil Refineries Limited, Toronto, Ont.
[12] Head of Department of Mechanical Engineering, University of Toronto, Toronto, Ont.

Most of the comments on the symbols used are very just; the author tried to use the A.S.M.E. symbols as far as possible, but in order to shorten the paper, he referred to a problem given in a text-book written in 1930, and thought it would simplify the matter to use the symbols there. He did, however, use Allievi's ρ in place of the K recommended, because the latter letter is so commonly used for such a variety of constants. It might have been better to have kept more closely to the A.S.M.E. recommendation.

The general statements of the paper are true for sloping and horizontal pipes, although the interpretation of the results should be made with care. The solution gives the ratios H/H_0 for the pressures where H is the total head, i.e. the sum of the elevation and the pressure head above a datum through the nozzle. The actual static pressure in the pipe at any point Z feet vertically above the gate is $H_0 - Z$ and the pressure there when water hammer occurs is $H - Z$.

Mr. McQueen suggests that the pump problem, Fig. 12, might be affected by cavitation and the presence of water vapour and air. No doubt water vapour and a little air do exist in the cavity on the reservoir side of the valve, and this would modify the water hammer, but the effect should be small because of the extremely low pressure of the vapour; cavitation could scarcely take place in any marked way.

The author agrees with Mr. Kerr in practically all of his discussion and commends him for the information brought out in his Table I. By repeatedly calling attention to the effects of closure from part gate, he is giving a warning as to pressure rises that might not have been expected. The N on Mr. Kerr's figures refers to the number of intervals of $2\,l/a$ sec. required for closure. Mr. Kerr's point as to the method of computing ρ is well taken, and his figures show, what the author omitted to say, that the pressure ratio at the gate for instantaneous closure is the value of H/H_0 where a sloping line at angle with tangent $-\,2\,\rho$ through A_0 (such as $A_0 A_{1.6}$ Fig. 6) intersects the axis of H/H_0.

In the discussions by Professor Wood, Mr. Strowger and Mr. Knapp, reference has been made to an article which was not known to the author till after he had actually read his paper. Undoubtedly, Professor Wood described the principle of intersecting parabolas and lines on which the paper is founded, but it can fairly be inferred that he did not realize the general application of the method, or he would have explained further uses of it in the nine years since his discussion first appeared. The author regrets, however, not having given Professor Wood credit for the work he did.

The broad application of Professor Wood's work, as described by Mr. Strowger, does not seem to be justified. Undoubtedly, equation (8) would fit certain parts of the author's paper, as Mr. Strowger has shown in Figs. 15 and 16, but in Fig. 16 the author's Fig. 6 has been redrawn and the notation of equation (8) applied to it. All of the writers consulted on the subject have developed the graphical construction from equations (6) and (7), and this is essential, because the use of equation (8) is limited to points at the ends of the pipe, whereas the others are not. The complete construction given in the paper could not have been developed from equation (8), but on the other hand, the author has shown how this equation fits such a case as the surge tank, Fig. 11, where the ends alone are considered; but equations (6) and (7) are very much simpler in this case also. The example, however, shows that both methods agree.

The author may perhaps be pardoned for quoting from a letter he received from Mr. Strowger: "I think you have made a distinct contribution to the engineering profession in giving such a complete analysis of so many special problems involving water hammer."

It may be remarked that Bergeron's solution, while giving the same results as in the paper, is slightly different to that used, and does not appear to be quite so easy to work out. Referring to Fig. 6, Bergeron omits all lines sloping parallel to $A_{1.6}\ C_{2.4}$; he finds the image of $A_{1.6}$ with reference to the axis of X and then draws $C_{2.4}\ A_{3.2}$ through this image, and so on.

The limitations of the constructions of Figs. 11 and 13 are ably described by Mr. Knapp, who is himself expert in the use of the construction described. The author appreciates the caution with reference to the correction for friction and agrees with it; he cannot, however, see that it makes any great difference in the problem of Fig. 11 as to the distribution of the friction, since only the ends of the pipe are being considered. His comments on Figs. 9 and 10 are correct, but the author never meant to suggest that a governor would give the results dealt with in these two cases. The paper was prepared to bring before English speaking engineers a graphical construction used abroad for water hammer, and to show how general it is by means of a wide variety of illustrations. As the cuts are naturally much reduced, conditions had to be assumed that would leave the illustrations clear, and that was done in these figures and in Fig. 12 as well.

The author also found that Loewy's construction was incorrect for intermediate points on a pipe, but is correct for end points.

Mr. Santos states that the author's paper does not add to our (meaning probably his own) knowledge of the subject, as no new problems are solved, and he reminds one of the sage who said that "there is nothing new under the sun." The author's "conclusion" makes his position clear, and Mr. Santos' remark would have been much emphasized if he had said where one could see these problems dealt with, as the author does not know. Further, in reply to Mr. Santos, the first sentence in the third paragraph of the paper expresses a statement made to the author many times by engineers who find Allievi's charts useful, in spite of their limitations, and the author points out that no difficulty of a mathematical kind does exist beyond the hydrodynamic equations. The arithmetical illustration was inserted to remove this difficulty.

With the limitations as to the effect of friction, Fig. 11 gives a very accurate and quick way of solving the surge tank problems. All intersections are made by lines very nearly at right angles, and the acute angles between the sloping lines do not determine such points. The author checked its accuracy with the arithmetic integration method and found it most satisfactory. One might criticize the fact that each step has to be made for $2\,l/a$ second intervals, whereas the time intervals for integration may, in some cases, be made very much longer.

The author knew the general historical facts mentioned by Mr. Macphail, and some of them are in the Halmos translation, but felt that he could not enlarge upon them as he wished, and therefore, wrote his own introduction and has no regrets regarding it. He has a great respect for the work of Allievi and of Joukovsky, and the evidence is that the modern water hammer theory is due to them. It looks like quibbling when one is criticized for calling a publication, the German translation of which occupies 155 printed pages, a book, even though Mr. Halmos calls it a paper and also a monograph. The translation by Mr. Halmos of Notes I to V occupies 132 printed pages and 45 full page cuts and also looks like a book.

Nothing is to be gained by answering Mr. Macphail's statement that the notation is not consistent. He has omitted parts of the author's definitions of certain terms, such as H, to prove his points, and some of his criticism is of little help to the engineer trying to understand the paper. Anyone wishing help from the paper would not waste his time trying to show that "some notation is wrong and then to infer what the author meant to say"; he would read what the author did say and would have no trouble. The author is still trying to find out what Mr. Macphail "meant to say" in his last paragraph. The notation is as perfect as the nature of the subject permits.

To Dr. O. Schnyder the author is again indebted and it is hoped that some time he will put all his solutions of problems together in printed form so that they will be readily available, because his ingenuity has enabled him to use the graphical construction for some very difficult cases. His discussion here, on the surge tank, provides a decided addition to the paper, as he has solved a much broader problem than the author did. The author only dealt with the conduit carrying water from the forebay to the surge tank and assumed the turbine to be very close to the tank, while Dr. Schnyder has taken into account also the effect of a long penstock from the tank to the turbine, and used an elegant solution simple in application. His exposition requires no further comment.

Dr. Schnyder appears to have made a mistake in equation (30). Where $t < \frac{3\, l_a}{a_a}$ the values of X are correctly stated but the values of Y should be $Y_{Ct3} = 1$ and $Y_{At1} = 1 + 2\ \rho_a$ and by substituting in equation (29) the left hand member of equation (30) should read $Y_{Bt} - 1$; although the right hand member of equation (30) and the construction of Fig. 19 are correct.

Also at the time $t \leqq \frac{l_a}{a_a}$ the value of Y_D should be unity and not zero.

Several persons have referred to the accuracy of the graphical solution, but there need be no anxiety on that score. The ordinary solutions are fully as accurate as arithmetic integrations made with a 10-inch slide rule, and greater accuracy may be obtained by enlarging the drawing and changing the relative scales till the intersecting angles are not much below 45 degrees. The author has found that mechanical schemes which enable the lines to be drawn parallel quickly are a great help, but these need not be mentioned.

In answer to a question raised by Mr. M. B. Watson, A.M.E.I.C., at the meeting, the author stated that the maximum pressure rise occurs at the gate, and the construction shows how to find the pressure rise at any point on the pipe. The author also replied to E. W. Dill, S.E.I.C., that the wave velocity a depends on the material of the pipe as well as on its diameter and thickness. A formula showing the relationship of the quantities is derived in the author's text, reference (3) of the paper.

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The Structure of the Engineering Profession

To-day one of the major difficulties in the successful operation of any engineering society or institution having to do with engineering education arises from the innumerable special branches into which engineering work is dividing itself. The resulting complexity is so bewildering that it is often hard to see the lines, if there are any, which divide the engineer from the physicist, the chemist or the mathematician on the one hand, and the technician, the industrialist or the business man on the other.

The profession or calling of the engineer is frequently looked upon as being essentially similar in structure to that of the architect, lawyer or medical man. The analogy, however, should not be carried too far, for none of these professions has both the highly developed system of specialization and the general limitation of the practitioner's work by commercial or economic considerations which exist in the case of engineering work.

An engineer's work must be based on his knowledge of fundamental scientific principles, but he must also take account of the information gained by experience in construction or manufacture, and his labours should ultimately lead to the production of something that can be beneficially operated or profitably sold. This requirement makes his work largely dependent on the exigencies of industrial life and enterprise, to an extent which does not exist in other professions.

Thus the profession of engineering is one which cannot be easily studied or classified, although such study is evidently necessary before any answer can be given to the question "what is the engineering profession?"

Addresses and papers such as those on the Status of The Engineer which appear elsewhere in this issue are evidence of the live interest which members of The Institute are taking in questions affecting the profession as a whole. These articles, however, deal with such topics as the engineer's concern with public affairs, the opportunities existing for him in industry, the consultant's relations with client and contractor, and the conditions of his employment in the public service. Studies of a somewhat different kind are necessary if a survey is to be made of the many technical branches which constitute the profession.

Classification, we are told, is the collection, under a common name, of a number of objects which are alike in one or more respects. When engineers are the "objects" considered, it is perhaps easier to find the respects in which they differ than the characteristics which they have in common. It is, therefore, not surprising that so little progress has been made in defining clearly the various classes under which professional engineers may be ranged, or even in deciding upon a satisfactory definition of what constitutes a professional engineer.

It seems evident that a general classification of engineering occupations must be made before those which are professional in character can be named, but on attempting such a task it is at once found that confusion arises between a man's professional title, the nature of his occupation and the designation of his official position, all of which are freely used in replies to enquiries as to a man's career. The question may arise, for example, as to whether an "assistant city engineer" is to be classed as a "highway engineer," or under what branch of engineering, if any, should we place a man who calls himself a filtration engineer, or a sound recording engineer.

Further, classification of some kind is necessary if engineers are to be licensed or registered, and at first sight the astonishing list of titles used by engineers or would-be engineers makes the task almost impossible.

Educational authorities have difficulty in framing their courses. They are confronted by such questions as, what is an acoustical engineer, what should he be able to do, and what course of training is desirable for him? Specialization has made headway even as regards the main divisions of engineering work, and some specialized sections which have arisen have attained almost to the dignity of the time-honoured civil, mechanical, electrical and mining branches of engineering. Educational programmes have become correspondingly complicated, particularly in the United States, where we are informed that in the state of New York alone, colleges and schools award over forty different degrees in engineering.

Mindful of all these difficulties, but driven by a scientific man's urge towards systematic classification, a well-known American authority on engineering education has recently made a gallant attempt to tackle this problem of engineering classification, which, indeed, is of primary interest in his field, where there is a continual conflict between the student's desire for early specialization and the claims of the broad fundamental subjects common to all branches of engineering.

In a paper* from which the title of this article is taken, Dr. Hoover gives the results of his studies of this subject. He took the modifying adjectives employed by 10,542 engineers listed in a well known biographical handbook, and found that they used 2,518 different titles in describing themselves. On analysis it appeared that these indicated 337 special branches of engineering. Some of the titles had reference to the users' general field of work, such as civil, electrical, metallurgical and the like, some indicated branches of technology, structures, materials, or products with which the specialist was concerned, as in the case of traffic engineer, ceramic engineer, or drying engineer, and a third category described the user's particular function, such as research, valuation, inspection, managing, sales, or distribution. It was found that nearly six hundred different significant words appeared in the titles studied.

The object of the investigation was to try to establish some standard scheme by which the recognized branches of the profession and the proper titles of engineers devoting

*The Structure of the Engineering Profession, Journal of Engineering Education, January, 1935.

themselves to specialized branches might be defined, and it was felt that, in the United States at least, a scheme of this kind might well be the task of a joint committee of the main national engineering societies.

In this connection Dr. Hoover suggests that all who are primarily engaged in work of an engineering nature, as distinguished from pure scientists and non-professional technicians, should use the word engineer as part of their professional titles; further, that all engineers should be asked to make a distinction between their professional title indicating their branch of engineering, and their present position indicating their place and rank in an organization. All professional titles should be based on two types of adjective: first, those indicating the field of work or zone of interest, and second, those indicating the function performed, as for example, electrical research engineer.

The paper gives lists of suggested adjectives respectively designating field of work, zone of interest, and function, by the use of which it is possible to make up more than ten thousand different combinations or descriptive titles whose meanings are clear.

So far, no systematic attempt at work of this kind has been made in Canada, although the matter is of undoubted importance both to the professional associations and to educational bodies. Further progress in the study of this difficult subject will be watched with interest.

A comprehensive and accurately descriptive list of recognized engineering titles would be of great assistance in connection with the licensing and registration of professional engineers. It seems remarkable that in Canada some of the Provincial Associations of Professional Engineers, as in the Province of Quebec, make no official distinction between the various branches of engineering, and in granting a license to practise do not state the particular line of work for which the holder is legally qualified. In contrast to this there are other associations, as in British Columbia, who recognize as many as seven main technical divisions of the profession, and have even begun to draw up schemes of functional classification for their members.

The matter is of interest in The Engineering Institute also, since our system of examinations for non-graduate applicants for corporate membership must provide for some degree of specialization. Actually, our examination programme recognizes civil, electrical, chemical, metallurgical, mining and structural engineering as main divisions, and this broad classification, with as many as four subdivisions in each case, has been found to work satisfactorily under present conditions. It remains to be seen whether we shall find it necessary to replace this comparatively simple list with a more complicated one based on some such study as that mentioned above. It seems doubtful, however, whether a further elaborate inquiry, along the lines suggested in Dr. Hoover's paper, would be of general advantage, but it would at least aid in showing the futility of some of the extraordinary titles assumed by persons who have no engineering training but who wish to take advantage of the public ignorance of the boundaries of legitimate engineering work.

Committee on Consolidation

The Committee appointed at the Annual Meeting of The Institute held in Toronto on February 7th, to develop the possibilities of the consolidation of the engineering profession in Canada, held its fourth meeting on Tuesday, April 16th, and reviewed the progress being made in organization in the various provinces for the discussion and compilation of data on the subject of Consolidation.

The Committee was of the opinion, from the information before it, that the engineering profession throughout Canada strongly approved the general principle of consolidation. It now becomes necessary to develop certain of the essential broad principles and to obtain the views of the various interested bodies as to the most acceptable procedure involved in such a reorganization. The consideration of these matters was unfinished when the Committee adjourned at 7.30 p.m.

The fifth meeting of the Committee was held in the University Club on the evening of Monday, April 22nd, and the general programme of the Committee was fully discussed and determined. It was decided to communicate with the various Branches and Provincial Committees in the near future, with reference to certain specific points involved in proposals for consolidation. The compilation of and report on the replies to this communication will be the Committee's next objective.

The Committee strongly urges Branches and Associations to meet as soon as possible for a discussion of this communication and the framing of a reply setting forth their views.

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Tuesday, April 23rd, 1935, at eight o'clock p.m., with Vice-President P. L. Pratley, M.E.I.C., in the chair, and six other members of Council present.

The Council received resolutions regarding the consolidation movement from the following branches: Halifax, Cape Breton, Quebec and Niagara Peninsula. A report was also presented from a joint committee of the Association of Professional Engineers of Nova Scotia and The Engineering Institute branches in that province, and a report from a similar co-ordinating committee in Saskatchewan. Both favoured the principle of consolidation. Council also received a copy of the Bill amending the Engineering Act in Manitoba, which has recently been passed.

It was noted that the April 1935 number of The Engineering Journal, containing papers and discussions on the western water problem, had been widely distributed to Dominion and Provincial Ministers, Senators, Members of Parliament, newspapers, and other public men and organizations interested.

The following committees were appointed:—

Past-Presidents' Prize Committee:
R. W. Boyle, M.E.I.C., *Chairman*
A. R. Chambers, M.E.I.C.
W. P. Dobson, M.E.I.C.
A. Frigon, M.E.I.C.
S. G. Porter, M.E.I.C.

Gzowski Medal Committee:
R. S. L. Wilson, M.E.I.C., *Chairman*
F. W. Alexander, M.E.I.C.
J. B. deHart, M.E.I.C.
H. J. MacLeod, M.E.I.C.
A. S. Wootton, M.E.I.C.

Leonard Medal Committee:
L. L. Bolton, M.E.I.C., *Chairman*
A. O. Dufresne, M.E.I.C.
G. V. Douglas, A.M.E.I.C.
B. S. McKenzie, M.E.I.C.
G. G. Ommanney, M.E.I.C.

Board of Examiners and Education:
H. M. White, A.M.E.I.C., *Chairman*
E. P. Fetherstonhaugh, M.E.I.C.
J. N. Finlayson, M.E.I.C.
N. M. Hall, M.E.I.C.
J. W. Sanger, A.M.E.I.C.
W. Walkden, A.M.E.I.C.

An amendment to the Saskatchewan Branch by-laws was submitted by the Branch Executive committee and duly approved.

Discussion took place as to the desirability of The Institute suggesting names of prominent engineers for inclusion in the proposed Economic Council of Canada, and it was decided to take steps with this end in view.

President F. A. Gaby, M.E.I.C., was asked to represent The Institute at the Annual General Meeting of the Royal Society of Canada, to be held at McMaster University, Hamilton, on May 21st to 24th, 1935.

The financial statement to March 30th, 1935, was presented and approved.

Fifteen resignations were accepted, four reinstatements were effected, six members were replaced on the active list, one Life Membership was granted, and three members were placed on the Non-Active List.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:—

Elections		*Transfers*	
Members	4	Assoc. Member to Member	3
Assoc. Members	4	Junior to Assoc. Member	3
Junior	1	Student to Assoc. Member	2
Students admitted	39	Student to Junior	4

The Council rose at eleven thirty p.m.

OBITUARIES

Joseph Hunter, M.E.I.C.

Members of The Institute will learn with regret of the death at Victoria, B.C., on April 8th, 1935, of Joseph Hunter, M.E.I.C.

Mr. Hunter was born at Aberdeen, Scotland, on May 7th, 1842, and received his early education there, at Marischal College. After completing his apprenticeship with James F. Beattie, C.E., he was engaged in railway work, surveying, building, etc., and in 1864 went to British Columbia, his route being by way of the Panama canal. Following his arrival in Victoria Mr. Hunter started for the Cariboo goldfields and there worked for seven years as miner and surveyor, in 1872 joining the Canadian Pacific Railway surveys. In 1873 he took a pack train from the head of Howe Sound up Cheakamus river through to Lillooet river, and in 1874 examined the region between the wagon road and Blue river on the North Thompson. In 1875 Mr. Hunter located for the Dominion government the Island Railway from Nanaimo to Mill Bay, linking up with the section located from Victoria to the latter point. In 1876 he was in charge of Y division of the C.P.R. and surveyed a line from the head of Salmon river across the summit and down the Nechaco towards Fort George. In 1877 Mr. Hunter was selected from the engineering staff of the C.P.R. by the Dominion government to lay off a provincial boundary line on the Stikine river between the Dominion of Canada and the Territory of Alaska in accordance with the terms of the Convention between Russia and Great Britain in 1825. Copies of his plan and his report are to be found in the archives at Ottawa, at Washington and in Downing Street, being accepted by the respective governments interested. In 1883 Mr. Hunter joined the Esquimalt and Nanaimo Railway as chief engineer, and remained with the railway for twenty years, being at various times, vice-president and general superintendent. He surveyed the route and all the structures of the railway were built from his designs. He also designed and built the waterworks system for the town of Ladysmith. In 1898 he was given leave of absence to design and build a dam across the Quesnel river at the outlet of Quesnel lake, a piece of engineering work which Mr. Hunter used to describe as the most satisfactory in his whole career. In 1905 Mr. Hunter was appointed chief engineer of the Wellington Colliery Company and Canadian Collieries Dunsmuir Limited. Following his retirement Mr. Hunter retained his active interest in the welfare of the Island.

Mr. Hunter joined The Institute (then the Canadian Society of Civil Engineers) as a Member on March 11th, 1913, and on June 15th, 1934, was made a life member.

Frank Welcome McCrady, A.M.E.I.C.

Regret is expressed in placing on record the death at Vancouver, B.C., on March 13th, 1934, of Frank Welcome McCrady, A.M.E.I.C.

Mr. McCrady was born at Lyn, Ontario, on November 7th, 1856, and received his early education at the High School, Brockville, Ont. Later he studied mechanical engineering, draughting and architecture.

After a number of years of junior work in Ontario and with the Canadian Pacific Railway, Mr. McCrady went to New Westminster in 1886, and after a year, during which he was engaged on engineering and draughting, he worked on the steel swing bridge for the Esquimalt and Nanaimo Railway, Victoria, B.C. He was also in charge of gas plant improvements at Victoria, and on soundings of the Fraser river at New Westminster, B.C. In 1893 Mr. McCrady was superintendent and manager of the Victoria Electric Light and Railway Company at Victoria. Later on he turned his attention to mining, but in 1904 was head of a party on the demarcation of the Canadian-Alaska boundary. The years 1905 to 1907 were again devoted to mining. From 1907 to 1912 Mr. McCrady was engaged on consulting engineering, covering a variety of work, and later, after four years' of illness, he became draughting demonstrator at the University of British Columbia. From 1920 until 1925 he was assistant in mechanical engineering at the same university.

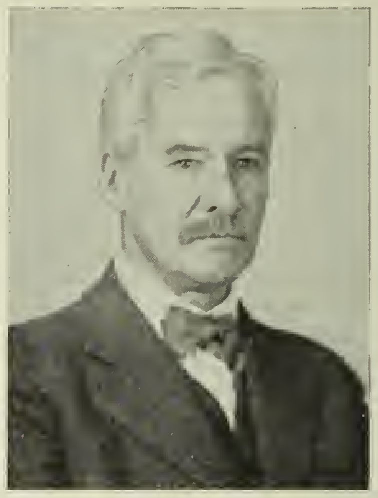
He was granted Life Membership in the Association of Professional Engineers of British Columbia.

Mr. McCrady joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on February 17th, 1898, and on December 22nd, 1925, was made a Life Member.

Thomas W. Lesage, M.E.I.C.

Regret is expressed in recording the death at Montreal on April 7th, 1935, of one of our senior members, Thomas W. Lesage, M.E.I.C.

Born at Montreal on December 29th, 1861, Mr. Lesage entered the service of the city in 1887 as assistant engineer in the waterworks department. In 1890 he was



Thomas W. Lesage, M.E.I.C.

transferred to the department of roads, which at that time managed the sewers also, and on January 1st, 1901, was appointed assistant superintendent of waterworks. Ten years later, in 1911, Mr. Lesage became superintendent of the aqueduct, and held that office until 1921 when he resigned, but was retained as consulting engineer to the department until January 1st, 1933, when he retired.

Mr. Lesage was one of the original members of the Canadian Society of Civil Engineers, having joined as an Associate Member on January 20th, 1887, and became a Member on December 21st, 1899. He was made a Life Member of The Institute on February 4th, 1930.

Charles-Edouard Gauvin, A.M.E.I.C.

It is with regret that we place on record the death at Quebec on April 10th, 1935, of Charles-Edouard Gauvin, A.M.E.I.C., one of the early members of the Canadian Society of Civil Engineers.

Mr. Gauvin was born in Quebec in 1853, and received his early education at the Laval Normal School, and later served his pupilage with Messrs. Ferdinand Peachy, Forbes, and later, Charles Baillargé. In 1874 he was admitted to practice as a Provincial Land Surveyor, and from that time until 1878 was employed as surveyor and draughtsman in the Crown Lands Office, and also, for a time as draughtsman, in the Department of Public Works of Quebec, working on the plans of the new Parliament Buildings. In 1879 Mr. Gauvin was engaged by the Quebec Street Railway Company, on the building of an extension of their line, and in 1880 he was assistant engineer on one of the divisions of the Newfoundland Railway Survey. In 1881 Mr. Gauvin was appointed teacher of industrial and architectural drawing in the Quebec School of Arts. In 1881 and 1882 he was with the Quebec Central Railway, being in charge of a party, and also fulfilling, for a time, the duties of assistant chief engineer. In 1882 Mr. Gauvin became superintendent of surveys for the Department of Crown Lands for the province of Quebec. In the same year, in association with Senator J. P. B. Casgrain, he founded the Quebec Corporation of Land Surveyors. In 1888 the Hon. Pierre Garneau decided to construct metallic bridges in the province, and Prime Minister Honoré Mercier brought out a Belgian engineer, Mr. Maquet, who constructed with Mr. Gauvin, the Malbaie and Garneau bridges.

At the beginning of the century the Hon. S. N. Parent established the hydraulic service of the province, and Mr. Gauvin was appointed chief engineer of this service, and prepared a scheme for the first hydraulic department on the St. Lawrence at l'Ile du Diable. He made studies for similar schemes for Paugan falls on the Gatineau, for the Manicouagan river, and for the Outardes river.

In 1910 Mr. Gauvin left the provincial government service to become secretary of the National Battlefields Commission under Sir George Garneau.

Mr. Gauvin joined The Institute (then the Canadian Society of Civil Engineers) on January 20th, 1887, as an Associate Member.

Charles John Pigot, A.M.E.I.C.

Members of The Institute will learn with regret of the death of Charles John Pigot, A.M.E.I.C., at Quebec, Que., on March 12th, 1935.

Mr. Pigot was born at Rochester, England, on October 21st, 1854, and was educated at St. Michaels College, Tenbury. The early part of his life was spent coffee planting in Ceylon; coming to Canada in 1889 he was employed until 1894 as leveller and assistant engineer on the construction of the Quebec and Lake St. John Railway, and in the year 1894-1895 he filled the same position on construction and surveys for the Great Northern Railway. He was later resident engineer on the construction of the de Lotbiniere and Megantic Railroad, and subsequently was engaged on the building and operation of the Quebec street railway system and the Quebec, Montmorency and Charlevoix Railroad. In 1911 Mr. Pigot was appointed chief engineer of the Quebec Railway Light and Power Company, and at the time of his retirement two years ago he was consulting engineer for the Quebec Power Company.

Mr. Pigot was a member of The Institute of many years standing, having joined the Canadian Society of Civil Engineers as an Associate Member on March 11th, 1897.

PERSONALS

T. G. Tyrer, A.M.E.I.C., deputy chief surveyor, Surveys Branch, Land Titles Office, Regina, Sask., was recently elected president of the Saskatchewan Land Surveyors Association.

R. M. Herbison, A.M.E.I.C., is at present engaged as hydraulic engineer with Messrs. Glenfield and Kennedy, Limited, Kilmarnock, Scotland. Mr. Herbison was at one time mechanical designer and field engineer in the mechanical department of the Dominion Bridge Company, Lachine.

Eric G. Adams, Jr.E.I.C., has accepted a position as economist on the staff of the assistant to the president of the Canadian Pacific Railway Company, Montreal. Mr. Adams was formerly secretary of the Newsprint Export Manufacturers Association of Canada, at Montreal.

W. L. McFaul, M.E.I.C., city engineer and manager of waterworks of the city of Hamilton, Ontario, was elected chairman of the Canadian section of the American Water Works Association for the year 1935-1936, at the convention held recently in London, Ont.

Louis A. Amos, M.E.I.C., senior partner of the firm of L. A. and P. C. Amos, Montreal, immediate past president of the Province of Quebec Association of Architects, has been elected a Fellow of the Royal Institute of British Architects by that body in recognition of his active efforts in furthering the work and prestige of the Quebec Association during his 1934 term as president.

A. J. C. Paine, A.M.E.I.C., staff architect of the Sun Life Assurance Company of Canada, Montreal, who graduated from McGill University in 1910 with the degree of B.Arch., is the winner of the gymnasia buildings architectural competition sponsored by the Graduates' Society of the University, it has been announced. Mr. Paine has been awarded the first prize of One Thousand Dollars cash, and when the buildings are actually constructed, will be commissioned to carry out the work.

G. W. F. Johnston, A.M.E.I.C., has joined the staff of Watson Jack and Company Ltd., of Montreal, and will be in charge of this company's construction equipment division. Mr. Johnston will also be associated with the work of the Canadian Sheet Piling Company Ltd., a subsidiary of Watson Jack and Company. He graduated from the University of Toronto in 1915 with the degree of B.A.Sc., and since that time has been connected with the construction industry as designing engineer, erection superintendent and sales engineer, and brings a wide experience to his new position.

F. K. Beach, A.M.E.I.C., of the Department of Lands and Mines, Edmonton, Alta., is the present chairman of the Edmonton Branch of The Institute. Mr. Beach was at one time with the Dominion Water Power and Reclamation Service of the Department of the Interior, and in 1927 was transferred to the North West Territories and Yukon Branch of the same Department at Calgary. In 1931 he became attached to the Petroleum and Natural Gas Division, Department of the Interior, at Edmonton, Alta., and has just recently received his present appointment.

G. V. Roney, A.M.E.I.C., has taken over the duties of chief engineer of Farand and Delorme, Limited, Montreal. Mr. Roney, who graduated from Queen's University in 1926 with the degree of B.Sc. was until October of the same year, structural detailer with the Canadian Bridge Company Walkerville, Ont. From that time until May 1927 he was senior draughtsman with the Pennsylvania State Highway Department, and from May to October 1927 was structural detailer with the Pittsburgh-Des Moines Steel Company, at Pittsburgh, Pa. In 1928 Mr. Roney was with F. L. Heughes and Company, Rochester, N.Y., and later, until June 1929, was with the Chesapeake and Ohio Railway Company, Richmond, Va. He has subsequently with the Manitoba Bridge and Iron Works, as checker on structural details, and was transferred to the Dominion Bridge Company, Winnipeg, in the same capacity when these firms amalgamated. In 1934 Mr. Roney joined the staff of the McColl Frontenac Oil Company in Montreal.

Edward Winslow-Spragge, A.M.E.I.C., has been appointed general manager of the Canadian Ingersoll-Rand Company Limited, Montreal. Following graduation from McGill University in 1908, Mr. Winslow-Spragge was for a year with Robert W. Hunt and Company at Sault Ste. Marie and Fort William, Ont. He then joined the staff of the Canadian Ingersoll-Rand Company at Toronto, and shortly after that was transferred to northern Ontario in charge of the Cobalt office. In 1911 he was transferred to the Montreal office. During the war Mr. Winslow-Spragge was engaged on the development of munitions manufacture in Canada, and subsequently became chief inspector and manager of the munitions department of his company. Following the armistice, he was appointed general sales manager, and in 1925 he became assistant general manager. In 1934 he was made first vice-president of the company. Mr. Winslow-Spragge is a member of the Canadian Institute of Mining and Metallurgy.

A. P. Linton, M.E.I.C., has been elected chairman of the Saskatchewan Branch of The Institute for the year 1935-1936. Mr. Linton graduated from the University of Toronto in 1908 with the degree of B.A.Sc. and following graduation was draughtsman with the Dominion Bridge Company until 1911. In 1911-1912 he was with the St. Lawrence Bridge Company working on the design of the Quebec Bridge, and from that time until 1915 was chief bridge engineer with the Department of Highways of Saskatchewan. From 1915 until 1919 Mr. Linton was overseas, serving with the 1st Canadian Pioneers, 9th Battalion, Canadian Railway Troops, in France, and commanded the 1st Bridging Company, Canadian Railway Troops, in Palestine. He was promoted to the rank of Major, was mentioned in despatches, and received the O.B.E. His present rank is Lieutenant-Colonel. Returning to Canada in 1919, he was appointed chief bridge engineer with the Department of Highways, Saskatchewan, which position Lieut.-Colonel Linton has held up to the present time.

W. E. Bonn, M.E.I.C., has been elected chairman of the Toronto Branch of The Institute for the year 1935. Mr. Bonn graduated from the Glasgow and West of Scotland Technical College in 1911, and came to Canada in the same year, being employed until 1913 by the Canadian Northern Railway. In 1913-1914 he was with R. B. Herrin and Company, contractors, on the design of special plant for work on the Toronto harbour development. From 1914 until 1918 Mr. Bonn was assistant resident engineer with the Department of Public Works on the Toronto harbour development and in 1918-1920 he was with James Stewart Inc. (Agents) Emergency Corp., and with the Canadian Stewart Company. During the years 1920-1927 Mr. Bonn was in charge of dredging with the Toronto Harbour Commission, and in 1927-1929 he was chief engineer of Roger Miller and Sons. Since 1929 he has been engineer in charge of the Toronto district for the Canadian Dredging Company Limited. Mr. Bonn is very active in Institute affairs, and was chairman of the Entertainment and Hotel Committee in connection with the Annual Meeting which was held in Toronto in February of this year.

A. Mailhiot, M.E.I.C., professor of mining geology and metallurgy at the Ecole Polytechnique and at the University of Montreal, recently received the honorary degree of Docteur des Sciences Appliquees from the University of Montreal. Dr. Mailhiot has contributed greatly to the knowledge of Canadian geology and mineralogy, having been in charge of many important surveys in the Gaspe, Abitibi and Eastern Townships districts. He has published a number of scientific papers dealing with different phases in these fields, and has delivered numerous lectures before learned bodies throughout Canada. Dr. Mailhiot is a director of the Provincial Mines Laboratory, registrar of the Corporation of Professional Engineers of the Province of Quebec, in the founding of which he took an active part, and a former chairman of the executive of the Canadian Institute of Mining and Metallurgy. In 1910 he graduated from the Ecole Polytechnique and joined the teaching staff of that school as assistant professor of geology and mining. Fifteen years ago Dr. Mailhiot was appointed professor of geology and mineralogy on the faculty of science in the University of Montreal. He has carried on post-graduate work at the Ecole des Mines and at the Museum of Natural History in Paris, and also at the Sorbonne.

S. L. deCarteret, M.E.I.C., has been elected a director, and appointed general manager of the Brompton Pulp and Paper Company Limited. Mr. deCarteret has been associated with the paper industry for twenty-seven years, and for the past eighteen months has been in charge of the woodlands operations of the Brompton Company. He graduated from Yale University with the degree of Ph.B. in civil engineering in 1908, and following graduation he was with the Riordon Paper Company, being engaged on topographic and forest surveys and in charge of office work in connection with the same. In 1910 Mr. deCarteret joined the Brown Corporation, being in charge of the department in connection with topographic and forest surveys, and investigations of water supply and water storage for power purposes. Two years later, with the same company he was engaged on the design and construction of dams, piers, etc., on the Ste. Anne river, Portneuf county, and subsequently on the construction and operation of the loading plant and private sidings at St. Casimir; the operation of the company's private railway and electric plant, Upper St. Maurice river, and the design and construction of various works at Bersimis, Saguenay county. In 1923 he joined the Hammermill Paper Company, and was for some years in charge of the company's properties and operations in the province of Quebec.

ELECTIONS AND TRANSFERS

At the meeting of Council held on April 23rd, 1935, the following elections and transfers were effected:—

Members

CHENEVERT, Joseph Georges, B.A.Sc., C.E., (Ecole Polytechnique), consltg. engr., associate with Arthur Surveyer & Company, Montreal, Que.

EWART, Henry Edward, of 243 First Ave., supt., Royal Canadian Mint, Ottawa, Ont.

KERR, Samuel Logan, B.S., M.E., (Univ. of Penna.), research and test engr., I. P. Morris Divn., Baldwin Southwark Corpn., Philadelphia, Pa.

MEALS, Caspar Dull, (Drexel Institute), wire rope engr., B. Greening Wire Co. Ltd., Hamilton, Ont.

Associate Members

AVERY, Eric, (St. Johns Tech. Sch.), chief engr., Dominion Bridge Co. Ltd., Calgary, Alta.

GODSON, Reginald Gilbert, (R.M.C. and Sch. of Mil. Engrg., Chatham), struct'l. engr., 28 Summerhill Gardens, Toronto, Ont.

LAPLANTE, René, B.A.Sc., C.E., (Ecole Polytechnique), asst. engr., Shawinigan Water & Power Company, Montreal, Que.

WINDSOR, Maurice, M.B.E., (Univ. Coll., London, Eng.), Canadian manager, Armstrong Siddeley Motors Ltd., Ottawa, Ont.

Junior

HUGGINS, Mark William, M.A.Sc., (Univ. of Toronto), engr., E. P. Muntz Ltd., Dundas, Ont.

Transferred from the class of Associate Member to that of Member

HOOVER, Owen Hugo, B.A.Sc., (Univ. of Toronto), engr.-in-charge, Dominion Water Power & Hydrometric Bureau, Dept. of the Interior, Calgary, Alta.

MILNE, Winford Gladstone, (Univ. of Toronto), vice-president and gen. mgr., N. Slater Company, Hamilton, Ont.

PERRY, Philip Carleton, divn. engr., C.N.R., Regina, Sask.

Transferred from the class of Junior to that of Associate Member

BOWMAN, Ronald Fraser Patrick, B.Sc., (Univ. of Alta.), roadmaster, C.P.R., Lethbridge, Alta.

BREAKEY, James, (Assoc., Sheffield Univ.), editorial dept., technical publications, MacLean Publishing Co., Toronto, Ont.

RIDGERS, Arthur Courtney, (R.P.E., B.C., by exam.), designing dftsman., Cons. Mining & Smelting Co. Ltd., Trail, B.C.

Transferred from the class of Student to that of Associate Member

OGILVY, James Angus, B.Sc., (McGill Univ.), 3429 Peel St., Montreal, Que.

RONEY, Gerald Von Suven, B.Sc., (Queen's Univ.), chief engr., Farand & Delorme Ltd., Montreal, Que.

Transferred from the class of Student to that of Junior

BOWLES, William Shedden, B.Sc., (McGill Univ.), estimating, design, etc., Canadian Stebbins Engrg. & Mfg. Co. Ltd., Montreal, Que.

GREENWOOD, Frederick Dwyer, B.Sc., (Queen's Univ.), mech'l. staff, Hollinger Cons. Gold Mines Ltd., Timmins, Ont.

MacDONALD, Arden Morris, B.Sc., (N.S. Tech. Coll.), Londonderry Stn., N.S.

PAMENTER, Archibald Francis, B.Sc., (N.S. Tech. Coll.), lab. asst., Imperial Oil Co. Ltd., Dartmouth, N.S.

Students Admitted

AHEARN, William J., (Queen's Univ.), 538 MacLaren St., Ottawa, Ont.

BIESENTHAL, Clarence G., (Queen's Univ.), 362 Christie St., Pembroke, Ont.

BODWELL, Geoffrey Lionel, (R.M.C.), Royal Military College, Kingston, Ont.

BONNEY, Albert J., (Queen's Univ.), 711 Water St., Peterborough, Ont.

BRICAULT, Fernand, (Ecole Polytechnique), 4312 Delorimier Ave., Montreal, Que.

BROWN, Ernest F., (McGill Univ.), 7219 Alexandra Ave., Montreal, Que.

CARMICHAEL, James Irving, (Queen's Univ.), 134 Cameron St., Fort William, Ont.

CHRISTIAN, John Despard, (R.M.C.), Royal Military College, Kingston, Ont.

COOPER, William Everett, (McGill Univ.), 60 Hall St. E., Moose Jaw, Sask.

DAVIS, Abraham Derek, B.Sc., (Univ. of N.B.), 42 Spring St., Saint John, N.B.

DOUCET, Jean, (Ecole Polytechnique), 10841 Berthelet St., Montreal, Que.

DUMONT, Georges Heliodore, (Ecole Polytechnique), 5707 St. Dominique St., Montreal, Que.

GILDEA, William Frederick Peter, (McGill Univ.), 3647 University St., Montreal, Que.

GUNNING, Merle Percy, (McGill Univ.), 591 Notre Dame Ave. St. Lambert, Que.

HARE, William Lester, (Queen's Univ.), 673 Gilmour St., Ottawa, Ont.

HEBERT, Camille Raymond, (Ecole Polytechnique), 4079 St. Hubert St., Montreal, Que.

HERBERT, Albert Cecil, (Univ. of Alta.), Wilkie, Sask.

HOUGHTON, John Ruse, (McGill Univ.), 730 Upper Belmont Ave., Westmount, Que.

HOWE, Harold Bertram, (Queen's Univ.), West Shefford, Que.

JOHNSTON, William David, (Univ. of Toronto), 583 Vaughan Rd., Toronto, Ont.

LeBEL, Gérard, (Ecole Polytechnique), 3716 Adam St., Montreal, Que.

LEFORT, Jean, (McGill Univ.), 5577 Phillips Ave., Montreal, Que.

LEMIEUX, Gilbert, (Ecole Polytechnique), 195 St. Jean St., Quebec, Que.

MacKAY, Ian Norton, (McGill Univ.), 4375 Montrose Ave., Westmount, Que.

MARSHALL, Lawrence James, (Univ. of Man.), Ashern, Man.

MATHIESON, John Richard, (Univ. of Man.), 642 Walker Ave., Winnipeg, Man.

McKIBBIN, Kenneth Holdsworth, (R.M.C.), Royal Military College, Kingston, Ont.

OXLEY, William Morrow, (R.M.C.), Royal Military College, Kingston, Ont.

PASK, Arthur Henry, (Univ. of Man.), Zenata, Sask.

PATON, Charles Peter, (McGill Univ.), 53 Wolseley Ave., Montreal West, Que.

PETERS, James Horsfield, B.Sc. (Chem.), (Univ. of N.B.), (McGill Univ.), Rothesay, N.B.

RINTOUL, William Vance, (Queen's Univ.), Burk's Falls, Ont.

ROSS, Thomas W., (McGill Univ.), 495 Prince Arthur St., Montreal, Que.

SMITH, Arthur James Edwin, (Univ. of Toronto), 22 Madelaine Ave., Toronto, Ont.

STEVENS, Robert L., (Univ. of Alta.), 9827–85th Ave., Edmonton, Alta.

THOMPSON, Robert, (McGill Univ.), 157–17th Ave., Lachine, Que.

WESTON, Norman O., (Univ. of Alta.), 11038–87th Ave., Edmonton, Alta.

WILKINS, Ronald Edward, (R.M.C.), Royal Military College, Kingston, Ont.

WINN, James, (McGill Univ.), 8289 St. Dominique St., Montreal, Que.

Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal regarding the exchange arrangements which exist between The Engineering Institute of Canada and the founder engineering societies of the United States, whereby members of The Institute may secure the publications of the American societies at special rates which in most instances are the same as charged to their own members. A list of these publications with the amounts charged is given below, and subscriptions may either be sent direct to New York or through Headquarters of The Institute.

	Rate to E.I.C. Members	*Rate to Non-Members*
American Society of Civil Engineers		
Proceedings, single copies	$ 0.50	$ 1.00
Per year	4.00*	8.00†
Civil Engineering, single copies	.50	.50
Per year	4.00	5.00
(Plus $.75 to cover Canadian postage.)		
Transactions, per year	6.00‡	12.00¶
Year Book	1.00	2.00
(Other publications 50 per cent reduction on catalogue price to E.I.C. members).		

* *If subscription is received before January 1st, otherwise $5.00.*

† *If subscription is received before January 1st, otherwise $10.00.*

‡ *If subscription is received before February 1st, otherwise $8.00.*

¶ *If subscription is received before February 1st, otherwise $16.00.*

	Rate to E.I.C. Members	*Rate to Non-Members*
American Institute of Electrical Engineers		
Electrical Engineering, single copies	$ 0.75	$ 1.50
Per year	6.00*	12.00*
(*Plus postage $1.00.)		
Transactions—annual, bound	6.00*	12.00*
(*Plus postage $1.00.)		
(The single copy price for Electrical Engineering includes postage charge.)		
The American Society of Mechanical Engineers		
Mechanical Engineering, single copies	$ 0.50	$ 0.60
Per year	4.00*	5.00
(*Additional Postage to Canada $.75, Outside United States and Canada, $1.50.)		
Transactions, bound, published annually, about May 15 (price of current volume)	10.00	15.00
(Other publications, same rate to E.I.C. members as to A.S.M.E. members.)		
Journal of Applied Mechanics—Quarterly publications.		
Dates of issue: March, June, Sept. Aug.	4.00	5.00
American Institute of Mining and Metallurgical Engineers		
Mining and Metallurgy, single copies	$ 0.50	$ 0.50
Per year	3.00*	3.00
(*Plus $1.00 for foreign postage.)		
Metals Technology, single copies	1.00	1.00
Per year	7.00*	7.00
(*Plus $.50 for foreign postage.)		
Transactions, per volume	5.00*	7.50
(*Plus $.60 for foreign postage.)		
Technical publications: Supplied at $.01 per page, with a minimum charge of $.25 for single copies, or at a subscription rate per year of	7.00*	7.00
(*Plus $1.00 for foreign postage.)		

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Civil Engineers:
Proceedings 1933-1934. Part 1, vol. 237.
Institution of Mechanical Engineers:
Proceedings 1934, vol. 127.
American Institute of Consulting Engineers Inc.:
Proceedings of annual meeting 1935.
The Society of Engineers Inc.: Transactions 1934.
Institution of Water Engineers: Transactions 1934, vol. 34.

Reports, etc.

American Institute of Consulting Engineers Inc.:
List of Members 1935.
British Columbia, Dept. of Lands, Lands and Surveys Branch:
Annual Report, 1934.
Canada, Dom. Water Power and Hydrometric Bureau:
Water Resources Paper No. 69, Surface Water Supply of Canada, Atlantic Drainage.
Nova Scotia Power Commission: 15th annual report, 1934.
Canada. Geodetic Survey:
Publication No. 42, Levelling. Altitudes in Quebec North of St. Lawrence River, and Publication No. 41, Levelling. Altitudes in Quebec South of St. Lawrence River.
Quebec Bureau of Mines: Annual report 1933, part C.
City of Winnipeg Hydro-Electric System: Annual report 1934.
Toronto Public Library: 51st annual report, 1934.
New Brunswick Electric Power Commission: 15th annual report, 1934.
Society of Automotive Engineers: Iron and Steel specifications, 1935.
American Society of Civil Engineers: Year Book 1935.

Technical Books, etc., received

Who's Who Among Association Executives, 1935. (*Institute for Research in Biography.*)
Practical Designing in Reinforced Concrete, Part III, M. T. Cantell. (*E. and F. N. Spon Ltd.*)
Radio Engineering, by F. E. Terman. (*McGraw-Hill Book Company.*)
Whitaker's Almanack, 1935.
American Society of Heating and Ventilating Engineers Guide, 1935.

BOOK REVIEWS

Resistance of Materials

By Fred B. Seely, John Wiley and Sons, New York, 1935. 6 by 9¼ inches, 436 pages, diagrams, etc. $3.75. Cloth.

Reviewed by J. N. Finlayson, M.E.I.C.*

The first edition of this book appeared in 1925 and was speedily adopted as a text in many leading universities. The author is professor of theoretical and applied mechanics at the University of Illinois. This second edition contains twenty chapters and three appendices compared with sixteen chapters and five appendices in the former edition, while the number of pages has been reduced from 442 to 436. The book is divided into two parts: Part I, embracing Elementary Topics, and Part II, Special Topics. The principal changes noted in Part I are the addition of review questions throughout the text, making the total number of problems nearly twice that contained in the former edition; the inclusion of a brief discussion on welded joints in chapter 2, and the omitting of chapter 3 on elementary combined stresses, distributing this material to other parts of the book.

In Part II a chapter on limitation of the flexure formula for sections having only one axis of symmetry has been added. The treatment of reinforced concrete beams has been extended and removed from Appendix IV to a chapter of its own in the main part of the book. Chapters on unsymmetrical bending, curved flexural members, and flat plates have likewise been reconstructed from material which was contained in Appendix V of the former edition. New chapters containing material not mentioned in the 1925 edition on thick walled cylinders, and tortional resistance of bars having non-circular cross-sections are added, and the moment-area method of the treatment of beams has been placed in two chapters, one dealing with the deflection of statically determinate beams, the other with statically indeterminate beams. Two chapters on double integration methods are included as formerly in Part I.

Instructors who carry on courses in testing of materials in conjunction with strength of materials may regret that the chapter contained in the former edition dealing with methods of measuring, and significance of mechanical properties of structural materials has been deleted. It is only fair to add, however, that the author has successfully implemented his professed aim in preparing the second edition to give special emphasis to the engineering significance of the subject and not merely to emphasize the mathematical methods of analysis.

*Professor of Civil Engineering, University of Manitoba, Winnipeg, Man.

Introduction to Electric Transients

By E. B. Kurtz and G. F. Corcoran, John Wiley and Sons, New York, 1935. Cloth. 6 by 9¼ inches. 335 pages, plates, figs., diagrams, tables. $4.50.

Reviewed by William Spriggs, Jr.E.I.C.*

This book, which John Wiley and Sons have just issued, is intended, primarily, as a text book for class use. The authors state, in their preface, that a sincere attempt has been made to reach the student and to provide him with the background which is necessary for advanced study in this field. In the usual undergraduate courses, formulae and expressions are developed which are valid only during the periods in which the circuits and machines are in their so-called "steady states." However, the steady state solution of a circuit problem is only one part of the complete solution, because a certain lapse of time is required, before the electrical conditions can adjust themselves to their ultimate steady state mode of variation. It is this time interval that is known as the transient period.

The volume is divided into a section for direct current transients, a section for alternating current transients and a mathematical appendix covering Heaviside's operational calculus, particular differential and algebraic equations and tables of exponential and hyperbolic functions. The method of presentation employed is to consider each type of transient under three distinct headings: physical considerations, mathematical analysis and oscillographic verification. Exercises are provided at the end of every chapter.

A good working knowledge of the elementary calculus is an essential requisite for anyone who wishes to gain something of real value from the book and this knowledge must be expanded as progress is made. Considerable use is made of Heaviside's operational calculus, an operational solution being given alongside the conventional one.

The student's assimilation of the text is helped very materially by the wide use which has been made of actual oscillograms, both to illustrate the text and to provide material for examples and exercises. The clearness of the printing, the excellence of the diagrams and illustrations and the smooth progress from problem to problem, hold the attention and encourage the interest of the reader.

The question of "power" transients has been given a prominent part and the attention of any engineer desiring some general information on transients in circuits containing variable resistance and inductance (such as incandescent lamps, transformers, motors and alternators) is referred to Chapter X on "Variable Circuit Parameters."

The work gives a clear and systematic presentation of the various types of transient problems and can be recommended as an excellent basis for postgraduate study.

*The Shawinigan Engineering Company Limited, Montreal.

BULLETINS

Culverts.—A 4-page folder received gives particulars regarding Ideal corrugated culverts manufactured by the Quebec Culvert Corp. Ltd., St. Hyacinthe, Que.

Caterpillar Equipment.—The Caterpillar Tractor Company, Peoria, Ill., have issued a 32-page booklet describing the company's products, which include tractors, graders, maintenance machines, power units and industrial engines.

Tube Benders.—Bulletin No. 39, containing 8 pages, published by the Parker Appliance Company, Cleveland, Ohio, gives details of the production tube bender and its capabilities.

Pumps.—The Worthington Pump and Machinery Corp., Harrison, N.J., have issued a 4-page leaflet describing the self-priming Worthington centrifugal monobloc pumping units, with capacities of from 50 to 400 gallons per minute, and total head of 25 to 150 feet.

Carbon Monoxide.—A 20-page booklet issued by Mine Safety Appliances Company, Pittsburgh, Pa., stresses the menace of carbon monoxide in industry, and gives information regarding the habits and toxic effects of this poison, and also the equipment developed to detect its presence, protect the individual and resuscitate the victim. Copies of this booklet are available without charge from the company.

Instruments.—A 24-page catalogue received from the Minneapolis-Honeywell Regulator Company Ltd., Toronto, Ont., gives particulars of the company's range of products, including controls of various kinds, protection relays, valves, automatic pilots, motors, flow meters, tachometers, hydrometers, thermometers, pressure gauges, etc.

Speed Reducing Units.—The Dominion Engineering Company, Montreal, have issued a 24-page booklet containing data regarding the company's standard speed reducing gear units, including tables to assist in the selection of suitable units for any purpose.

Special Products.—An 8-page leaflet received illustrates the various products manufactured by the by-products steel division of the Lukens Steel Company, Coatesville, Pa., including such items as plates of 50,000 pounds, 25-inch thickness; fly wheels; base plates; locomotive fire boxes; engine frames; tank cars; fusion welded pressure vessels, etc.

Valves.—Bulletin No. 38, a 60-page publication issued by the Parker Appliance Company, Cleveland, Ohio, covers a typical variety of valves manufactured by the company, together with specifications covering straight globe, angle globe, cross globe, straight flow valves, drain cocks, etc.

Alarm Equipment.—Edwards and Company of Canada Ltd., Montreal, have issued a 16-page booklet containing specifications and price list of the company's alarm bells and buzzers of various kinds, musical chimes, industrial horns and sirens, signalling transformers, fire and emergency stations, etc.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

The Wind Sail as Applied to Yachts

At the January meeting of the Branch several of the committee reports were read. Mr. Davison read the financial report; B. Candlish, A.M.E.I.C., spoke for the papers committee, and T. H. Jenkins, A.M.E.I.C., submitted the report for the membership committee.

The guest for the evening, Dr. W. F. Gerhardt, was introduced by Mr. Candlish. Dr. Gerhardt, with Mr. Locke as his assistant, is in charge of the Department of Aeronautics at Wayne University. The subject presented was "The Wind Sail as Applied to Yachts." Dr. Gerhardt gave a short synopsis of sailing from the time our ancestors straddled a log and held a branch aloft going wherever the wind took them, to the present day of international yachting and close sailing into the wind.

There have been several types of air-foils or power sails. The passing wind-mill, the various types of rails used as driving power for boats and Dr. Flintner's rotating cylinder are well known.

The important problems in sailing these days are: (1) the danger and difficulties of the swinging boom; (2) the instability of the vessel; (3) the drag of the hull in the water.

The method of overcoming the first difficulty was to do away with the boom and use the airplane wing in a vertical position as a sail, the ribs of the wing being convex on both sides and the sail (taking the place of the fabric on an airplane wing) covering the wing loosely. In this manner the sail automatically takes a streamline form in which way the wind is striking the sail. The ribs of the wing are attached firmly to the mast. Bearings at the foot of the mast allow the sail to swing when the course of the vessel is changed.

A good deal of experimenting has been attempted in keeping the boat level, the main one being the use of double hull vessels.

In attempting to overcome the drag on the hull, the speaker resorted to hydro-foils to raise the hull out of the water, thus decreasing its resistance.

A hearty vote of thanks was moved by T. Jenkins and extended to Dr. Gerhardt and Mr. Locke by H. J. Coulter, A.M.E.I.C.

Calgary Branch

John Dow, M.E.I.C., Secretary-Treasurer.
H. W. Tooker, A.M.E.I.C., Branch News Editor.

Joint Dinner

To further the establishment of closer relationship between the various branches of engineering in Canada, a joint dinner was held by the Calgary Branch of The Institute, the Association of Professional Engineers of Alberta, and the Canadian Institute of Mining and Metallurgy in the Renfrew club on Saturday evening, February 16th. Approximately eighty were present, and the dinner was presided over by P. Turner Bone, M.E.I.C.

The advantages to be derived by such a gathering of the three associations were stressed by G. P. F. Boese, A.M.E.I.C., chairman of the Calgary Branch.

J. B. de Hart, M.E.I.C., of Lethbridge, representing the Professional Engineers, spoke on the proposed amalgamation of the three associations, and contributed various suggestions as to how this might be accomplished. J. M. Stevenson of Calgary contrasted the methods of engineering advertising with those of other industries and businesses. Dr. J. O. G. Sanderson of Calgary brought the greetings of the Mining and Metallurgical Institute.

Community singing led by W. B. Trotter, A.M.E.I.C., and G. H. Patrick, A.M.E.I.C., was the feature of the evening, and the gathering was also entertained by Ted Forsey's orchestra.

Two motion pictures comprising seven reels in all, entitled "Empires of Steel," showing the construction of the Empire State Building in New York, and "Span Supreme," showing the erection of the George Washington bridge, which spans the Hudson river from 177th to 178th Street, New York (known as Fort Washington), to Pallisades on the New Jersey side (known as Fort Lee), were the features of the programme of the last general meeting of the season of the Calgary Branch, on Thursday, February 28th, 1935, at which well over a hundred members and their friends were present.

By the kindness of the Otis-Fensom Elevator Company, through their local representative Mr. W. W. Pratt, the Branch was privileged to witness these films. Mr. Pratt also gave a short address pointing out the salient features.

This meeting was also chosen for the presenting of the prize to I. Abramson, Jr.E.I.C., the winner of the competition for the younger members. F. N. Rhodes, A.M.E.I.C., one of the adjudicators, made a few remarks on the rules governing the competition.

A hearty vote of thanks was given to Mr. Pratt by the chairman, and G. P. F. Boese, A.M.E.I.C., congratulated Mr. Abramson on his winning the prize.

By the kindness of the ladies, refreshments were served following two violin solos given by Miss Mary Makar, assisted at the piano by Mrs. G. P. F. Boese.

The meeting adjourned at 11 o'clock p.m.

Annual Meeting

The annual meeting of the Calgary Branch of The Institute was held in the Lougheed Building on March 9th, 1935, and took the form of a luncheon meeting at which some twenty-two members were present. Community singing led by G. H. Patrick, A.M.E.I.C., was indulged in.

Following the lunch, S. G. Porter, M.E.I.C., addressed the meeting on phases of the annual meeting held in Toronto, February 7th, 8th and 9th, 1935, stressing chiefly the drought situation in the prairie provinces on which papers were presented. He also gave a short outline of the discussion on the consolidation of engineering organizations throughout Canada, stating that a committee had been appointed with Mr. G. McL. Pitts, A.M.E.I.C., as chairman to report on the subject. To enable the committee to keep in touch with Branch affairs, a branch correspondent, R. S. Trowsdale, A.M.E.I.C., was appointed.

Following Mr. Porter's address, Colonel F. M. Steel, M.E.I.C., Councillor for the Branch, reported on a visit made to Headquarters and congratulated the chairman, G. P. F. Boese, A.M.E.I.C., on the attendance at the Branch meetings. He suggested that contact be maintained with the non-active members to make it as easy as possible for them to return to active membership when they are in a position to do so.

Mr. Porter, on behalf of the members, presented Mr. Dow with a travelling bag in appreciation of his so efficiently performing the duties of secretary-treasurer during his two years of office. In reply Mr. Dow took the opportunity of thanking the members of the Executive for their co-operation, which to a great degree lightened his work.

Reports were read by the convenors of the various committees, which reflected gratifying results, especially the secretary-treasurer's; this showed transactions to the amount of $284.72 and assets totalling $1,030.31 with no liabilities.

On a motion proposed by P. Turner Bone, M.E.I.C., and seconded by G. H. Patrick all reports were adopted.

The result of the ballot in the election of officers was reported by the scrutineers.

Prior to John Haddin, M.E.I.C., the new chairman, taking the chair, Mr. Boese thanked the committees and the Executive for their co-operation, especially the Programme committee. Mr. Boese said that the welfare of the Branch had been well advanced by the timely visit of President F. P. Shearwood, M.E.I.C.

F. N. Rhodes, A.M.E.I.C., suggested a joint meeting with similar organizations in the United States, preferably in Montana or other states near the border. This suggestion was referred to the incoming Executive.

The meeting adjourned at 3.45 o'clock p.m.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

Members of the Branch and guests to the number of four hundred and fifty gathered in the auditorium of the Hamilton Technical Institute on the evening of Tuesday, March 12th, 1935, to hear Mr. D. A. Boyd of the Dominion Bridge Company, Montreal, speak on "Arc Welding."

Mr. Boyd has already addressed several Branches of The Institute and his fame had preceded him to Hamilton, hence the large audience, for in this district the steel industry is of the greatest importance.

The chairman of the Branch, W. Hollingworth, M.E.I.C., occupied the chair and welcomed the visitors who came from outlying points such as Galt, Brantford, Dundas and Grimsby as well as the city of Hamilton. Mr. Boyd was introduced and gave a most instructive talk, in a masterly way showing that he was thoroughly familiar with the subject and was well able to set it out clearly to the audience.

At the close of the address a number of questions were asked and answered. Interesting test pieces and models were also shown and explained. Mr. Paulin proposed a vote of thanks to Mr. Boyd and this was enthusiastically endorsed by the members and friends present.

The following paragraphs give the substance of the lecture delivered by Mr. Boyd who, in addition to being an expert on welding, is also a remarkably able speaker.

Arc Welding

The great heat of the electric arc process was first determined by a Frenchman in 1880. Two years later a Russian developed the first carbon arc process.

The intense heat developed is in the neighbourhood of 5-6,000 degrees C., where under 20-30 volts, and under the influence of heat, air between the electrode and the steel is ionized assisting a flow of current across an apparent void. Without the ionization of the air, the arc would not be continuous and welding would be impossible. Under the influence of this intense heat, both the parent metal and the electrode becomes fluid and the molten electrode is drawn to the article to be welded by virtue of the latter's positive polarity. Without the fluidity of the metal to be welded the electrodes metal would freeze in globules on its surface. Thus the electrode particles actually become a part of the metal to be welded. In this consideration the speaker compared bare and coated electrodes.

Investigation of many weld failures led Mr. Boyd to the conclusion that weld design and not welding practice was responsible for practically all weld failures. Properly designed joints, Mr. Boyd said, were almost 100 per cent efficient. The weld metal should be as close as possible in analysis to the stock to be welded. Over 0.25 per cent carbon, serious difficulty is encountered in arc welding.

Mr. Boyd completed his lecture by showing a great many slides which were indicative of the types of work handled by electric welders. These served to demonstrate the tremendous advances in modern welding and many showed interesting stress distributions in welded joints.

Highlights of European Nights

The annual joint meeting of the Toronto Branch A.I.E.E. and the Hamilton Branch E.I.C. was held in the Westinghouse Auditorium on Friday, April 12th, 1935, when Mr. S. G. Hibben, Director of Applied Lighting of the Westinghouse Lamp Manufacturing Company of Bloomfield, N.J., addressed the meeting on the subject of "Highlights of European Nights." The attendance was two hundred.

Mr. Hibben carried the assembly on a travelogue from New York to the British Isles, and Central Europe with a lecture profusely illustrated with photographs showing various types of lighting—both domestic and public. Such structures of international interest as Big Ben, the Arc de Triomphe, the Rhine castles and Notre Dame were shown in their nocturnal beauty even more pronounced than in daytime. Mr. Hibben went on to show various indirect and direct lighting systems of homes, stores and streets of Europe. In Germany and Holland, highway lighting was of a much more superior type than in Canada. Sodium tube lighting makes travel highways and rural districts safe for high speed, while mercury arc high voltage equipment is particularly applicable to civic lighting.

Light may be produced from three common sources: Chemical, low efficiency methods; high voltage methods; and low voltage ionization processes.

In connection with the first method, the speaker demonstrated that light of short life could be produced by mixing in water a hydrozine with potassium ferrocyanide to produce a "cold" light. Even ice has little effect upon this light, and constant stirring will prolong the life of the light. This method is of little practical use at present, but may be utilized in the future.

The speaker then demonstrated by screen projection the types of failures met in normal incandescent lamps under accelerated conditions. Water vapour—the least trace—caused blackening and possible fire hazard by arcing. Air in the bulb caused blackened condition and rapid deterioration of the filament; the use of a metal like molybdenum was shown to be unsatisfactory due to filament warpage and low life. Poor tungsten, too, failed when tested, by warping and breaking prematurely. All these types of failures brought home to the listeners the fact that incandescent lamp design and control was no easy matter.

In explaining the action of metallic arc principles, the speaker illustrated by sketches of the accepted electronic structure of the elements. When bombarded with electrons, some of the electrons which normally rotated about the nucleiic proton were disturbed from their regular paths by actual collision with the current's electrons and in returning again to their natural paths, the elements' electrons emitted a spark. This gives rise to light. Mr. Hibben then demonstrated the features of various arc type bulbs—the mercury arc, sodium, and the amalgam (cadmium, zinc, etc.,) tubes were actually shown in operation. Their uses were limited due to their lighting characteristics; the sodium light was intensely yellow and turned red, and other dark colours, to black, and lighter shades to a white or grey; the mercury light gave a peculiar greenish tint, while the amalgam light gave a pinkish hue. The latter type is a new development with, as yet, few uses, but the other types are greatly used, especially on the continent. Sodium light is objectionable due to its tendency to show colours as black and white alone, and for this reason is used only in rural lighting, for highways, etc., while the mercury arc vapour lamp is more applicable to downtown sections where foliage and colouring generally is to be preserved.

Mr. Hibben closed by describing some of the operating characteristics of the various types, and was accorded a hearty vote of thanks by the assembly. The interest of the meeting was manifested by the nature of the questions asked when the meeting was thrown open for discussion. The meeting was adjourned after a vote of thanks to Mr. Hibben and officials of the Canadian Westinghouse Company, and refreshment furnished by the latter was thoroughly enjoyed.

Moncton Branch

V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.

Consolidation

On March 14th, 1935, R. F. Legget, A.M.E.I.C., secretary of the Committee on Consolidation, visited Moncton and was entertained at luncheon by the Executive of the Branch. Mr. Legget spoke briefly on the proposed co-ordination. During the discussion that followed, the opinion was expressed that in New Brunswick no great need for amalgamation had been felt. The Institute branches and the Professional Association were performing their respective educational and legal functions satisfactorily, and furthermore the fees of the Professional Association were very low. At the same time, for the good of The Institute as a whole, Moncton Branch was ready to co-operate with the Committee. The Executive were pleased to learn that it was not proposed to eliminate the branches. Loyalty of the individual member to his branch, in their opinion, was responsible for holding The Institute together during the depression years.

Nickel and Its Uses

"Nickel and Its Uses" was the subject of a very interesting address delivered before the Branch on April 1st by T. H. Dickson, B.Sc., A.M.E.I.C. H. B. Titus, A.M.E.I.C., vice-chairman of the Branch, presided.

Although known to the ancients, it is only within the last fifty years that the metallurgical importance of nickel has been realized. When combined with other metals, notably iron and steel, alloys of great strength and toughness are produced.

Notwithstanding nickel is found in eight other countries, Canada supplies 90 per cent of the world's requirements. This is made possible because of low production costs and a stabilized price.

A vote of thanks to Mr. Dickson was moved by G. E. Smith, A.M.E.I.C., seconded by E. R. Evans, M.E.I.C.

Three motion pictures were then shown. The first, "Power," showed construction and operation of the C.N.R. giant locomotives. "Making Money," the second film, showed the various coinage processes at the Royal Mint at Ottawa. "Forest Fighters of the Skies" was the final picture. The standard motion picture projector recently purchased by the Branch, was used on this occasion and the chairman extended the thanks of the members to H. J. Crudge, A.M.E.I.C., for giving the Branch the benefit of his experience in selecting and negotiating the purchase of the motion picture equipment.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Junior Section

On March 25th, 1935, two papers were presented before the Section, one by C. R. Whittemore, A.M.E.I.C., metallurgist with the Dominion Bridge Company, Lachine, on "The Metallurgy of Metallic Arc Welding," and one by Gordon Cape, who is also with the Dominion Bridge Company, on "Welding Procedure."

C. J. Pimenoff, S.E.I.C., acted as chairman.

Water Purification

W. S. Lea, M.E.I.C., consulting engineer, of Montreal, on April 4th, 1935, gave a most interesting talk on the history, recent developments and special processes used in water purification.

Professor R. E. Jamieson, M.E.I.C., was in the chair.

Basic Principles in Making Durable Concrete

The above was the subject of an address given by E. Viens, M.E.I.C., director of Testing Laboratories, Department of Public Works, Ottawa, on March 28th, 1935. He defined Portland cement and concrete, gave particulars regarding various mixtures, aggregates and control of water cement rates, and also data on the placing and curing of concrete.

Previous to the lecture a dinner was held at the Windsor Hotel. J. S. Brett, A.M.E.I.C., presided.

Junior Section

On April 8th, 1935, papers were presented on the "Operation of the Kaelin Electric Steam Generator" by H. C. Buller, S.E.I.C., assistant engineer with the Dominion Rubber Company, Montreal, and another on "The Small Maintenance Shop" by Paul Poitras, engineer with the Steel Company of Canada, Montreal.

The first paper covered the reasons for the installation, general theory, testing and operation of an 8,000 kw. unit, and the second paper was a study of layout, equipment and operations in general in the small maintenance plant.

Jules Archambault acted as chairman.

Electric Heating

On April 11th, 1935, Mr. Lee P. Hynes, consulting engineer of New York, gave a paper on "Electric Heating as Applied to Hydraulic Control Gates, Buildings and Industrial Processes." He described many of the recent developments and stated that as any radical change in the thermal efficiency of electric heating could not be expected, improvements must be obtained in the engineering technique for applying and controlling the heat.

A dinner at the Windsor hotel was held previous to the meeting. The chairman was Max V. Sauer, M.E.I.C.

The Smoker

The Montreal Branch smoker was held on April 12th, in the Rose Room of the Windsor hotel, and was attended by nearly three hundred and fifty members and guests.

The arrangements were under the direction of R. H. Findlay, M.E.I.C., and his smoker committee, who provided an excellent series of amateur turns and skits. The music was furnished by the D.B. and D.E.W. Amateur Orchestra with Mr. F. F. Cleal as conductor. F. S. B. Heward, A.M.E.I.C., chairman of the Branch, and Dr. F. A. Gaby, M.E.I.C., president of The Institute, both gave short addresses.

The X-ray in Metallurgy

The various uses of the X-ray in metallurgy were described by Andre Hone, D.Sc., lecturer in metallurgy at the Ecole Polytechnique, Montreal, on April 18th, 1935. His talk was well illustrated with lantern slides.

F. S. B. Heward, A.M.E.I.C., presided.

JUNIOR SECTION—PLANT VISIT

On Monday evening, April 22nd, 1935, some forty members visited the pipe mill of the Steel Company of Canada, on St. Ambroise Street.

A general talk on the manufacture of pipe was given by Mr. Blampied, plant superintendent, after which the party went through the plant. Refreshments were also served through the kindness of the Steel Company.

Niagara Peninsula

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

This Branch held a joint meeting with the Niagara District Chemical and Industrial Association at St. Catharines on April 11th, 1935, with Mr. A. E. H. Fair as chairman and T. Stanley Glover, A.M.E.I.C., as speaker. About one hundred members and guests were in attendance.

Messrs. E. G. Cameron, A.M.E.I.C., W. R. Manock, A.M.E.I.C., and Paul Buss, A.M.E.I.C., spoke briefly as to the aims of The Institute, the fields of usefulness of the two organizations and of proposed meetings in the future.

Mr. Glover showed some most interesting lantern slides and told of his experiences while employed with the administration of the Crown Colony of Nigeria. This colony, on the west coast of Africa, is about the size of Ontario and is inhabited by some 20,000,000 blacks and 4,000 white people. There are more than one hundred dialects spoken, which makes the administration somewhat difficult. No white man is allowed to own land.

The northern portion, wherein the higher type of black is encountered, is subject to indirect rule with native chieftains acting in the Legislative Assembly, whereas the southern half is administered directly by white officials.

Two thousand miles of 3-foot 6-inch-gauge railway are already built and the ports of Lagos and Harcourt are quite modernized.

Palm kernels and oil are the principal exports but the mineralized portions of the country contain coal, tin ore and some gold. There are possibilities of trade for some of our Canadian products which might be well worth looking into.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

THUNDERSTORMS AND ATMOSPHERIC ELECTRIC EFFECTS

The noon luncheon on March 7th, 1935, was addressed by D. C. Rose, Ph.D., of the National Research Council, on the subject "Thunderstorms and Atmospheric Electric Effects." The address was illustrated with lantern slides.

Past chairman A. K. Hay, A.M.E.I.C., presided and in addition head table guests included: J. L. Busfield, M.E.I.C., of Montreal, Hon. R. B. Hanson, Dr. H. M. Tory, Dr. C. Camsell, M.E.I.C., R. C. Rose, Engr.-Com. A. D. M. Curry, M.E.I.C., Lieut.-Col. W. A. Steel, A.M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., J. Murphy, M.E.I.C., J. T. Johnston, M.E.I.C., R. Meldrum Stewart, M.E.I.C., and E. M. Dennis, A.M.E.I.C. The chairman, in introducing the head table guests, made mention of the fact that Mr. Dennis for a number of years had been a prominent member of the Proceedings committee of the Ottawa branch and was now retiring from this committee membership.

The first part of the address dealt with the electrical state of the atmosphere in normal fine weather. The air of the atmosphere is to a small extent charged with electricity. It contains minute particles which carry positive and negative electrical charges. These are called ions and their existence makes the air a conductor of electricity. However, it is a very poor one being about of ten thousand million times lower conductivity than copper.

The density or amount of ionization increases with height and the fact that there is more positive electricity at higher altitudes results in an electrical field which is constantly driving positive electricity to the earth's surface. A constant current of about 1,000 amperes flows into the earth from the atmosphere. To a large extent, if not entirely, this is compensated for by the fact that during thunderstorms the electric field is reversed and higher currents flow upwards in lightning flashes and discharge off trees and points.

Dr. Rose discussed the meteorological effects leading up to thunderstorms. There are two general types: the first, or heat storm, which is local and occurs in fine weather when there is little or no wind; and the second, which is caused by instability in the atmosphere due to the movements of large bodies of air associated with low pressure centres. The latter, sometimes known as cyclonic storms, move across continents more or less regularly. There are many things not yet completely understood with regard to the process of building up the electrical charge in the thunderstorm, but in some manner the bottom of the cloud becomes negatively charged and the upper parts positive. When the potentials are great enough to break down the air in between, a lightning flash takes place. The majority of these flashes are from cloud to cloud, a small percentage only occurring between cloud and ground.

The speaker presented some interesting information regarding the estimated amount of energy that occurs in lightning flashes. For instance, it has been estimated that there are about seventeen billions of joules in the average lightning flash, which is enough energy to convert about seven tons of water from 0 degree C. into steam. There are estimated to be about one hundred flashes of lightning taking place on the average every second throughout the world, which means a continuous dissipation of about two thousand million horse-power. This again represents only a fraction of the total energy stored up in the atmosphere in storm conditions.

In some countries detailed observations are being obtained on the distribution, not of thunderstorms but of lightning flashes to the ground, with relation to the topographical and other features of the country so that data may be collected which would help in locating transmission lines in positions least likely to be struck. So far the information is insufficient and not very conclusive.

SOME BASIC PRINCIPLES IN MAKING DURABLE CONCRETE

At an evening meeting held on Thursday, March 21st, 1935, in the rooms of the photographic section of the Royal Canadian Air Force, Jackson building, the members of the Ottawa Branch listened to an address by Mr. J. W. Lucas, of the staff of the Testing Laboratories of the Department of Public Works. Mr. Lucas spoke upon "Some Basic Principles in Making Durable Concrete," his address being illustrated with lantern slides. It was prepared in collaboration with E. Viens, M.E.I.C., director of the Testing Laboratories of the Department of Public Works.

In Canada in a single year, as Mr. Lucas explained, as much as $100,000,000 has been spent on concrete, a figure which alone justified every effort to secure a good quality in the product. Inconvenience and cost in repairing or replacing leaking walls, dusty floors and deteriorating structures, are added reasons for warranting the study of methods for producing the very best, most serviceable and most durable kinds of concrete.

The composition of cement, the mixing of the concrete including particulars with regard to aggregates, and the water rates were referred to. The speaker also gave some interesting information with regard to the filling of forms and the curing of concrete.

Following the address, the meeting was thrown open to discussion in which many of those present participated.

PULP AND PAPER

About one hundred and fifty members and their friends attended a noon luncheon at Standish Hall, Hull, P.Q., on Saturday, March 30th, 1935, and afterwards paid a visit to the plant of the E. B. Eddy Co. Ltd. At the luncheon, W. S. Kidd, A.M.E.I.C., production manager for the company, gave an address on "Pulp and Paper" preliminary to the visit of inspection. Luncheon guests at the head table included a number of the officials of the company. Dr. R. W. Boyle, M.E.I.C., chairman, presided.

Mr. Kidd in his address briefly traced the history of paper-making and outlined the various steps in present-day processes, illustrating them with lantern slides.

The speaker stated that men with training in the various branches of engineering, particularly mechanical, electrical, civil, chemical and forestry, deserve much of the credit for making Canada the largest newsprint producing country in the world, and Canadian mills the most efficient.

Until a few years ago the engineers' activity in the industry was confined to the designing and building of paper mills. Gradually, however, they have been taken into the operating organization, so that today they are found in all departments, from the woods to the shipping room, striving continually to make better paper cheaper.

The future of the technically trained man in the paper industry is bright, for he alone is equipped to solve the many problems still to be found in every department.

In the course of the afternoon's inspection trip a train of several cars was provided for transferring the guests from one end of the grounds to the other. The main units of the plant were visited, including the wood room, wood clearing department, sulphite mill, groundwood mill, and the different mills for the manufacture of newsprint and other papers.

SPECIAL MEETING ON CONSOLIDATION

A special meeting of the Branch was held in the R.C.A.F. Rooms, Jackson Building, on the evening of April 9th, 1935, in order to afford the members an opportunity to discuss a resolution of the last annual meeting of The Institute on the possibilities of consolidation of the engineering profession in Canada. At this meeting J. L. Busfield, M.E.I.C., and R. J. Durley, M.E.I.C., the general secretary, both of Montreal, attended.

The matter of possible consolidation was discussed and Dr. R. W. Boyle, M.E.I.C., and A. K. Hay, A.M.E.I.C., were appointed as a committee of two to confer with the members of the Ontario Association of Professional Engineers in the Ottawa district regarding the matter. After the opinions upon the possibility of consolidation had been obtained by this committee, it was to communicate its findings and report back to the general committee of The Institute on Consolidation, under the chairmanship of Gordon M. Pitts, A.M.E.I.C., of Montreal.

Quebec Branch

J. Joyal, A.M.E.I.C., Secretary-Treasurer.

The Isle of Orleans Bridge

At a meeting of the Quebec Branch of The Institute held on April 8th, 1935, P. L. Pratley, M.E.I.C., described the construction of the Isle of Orleans Bridge, and O. Desjardins, A.M.E.I.C., chief engineer of the Department of Public Works, who thanked the speaker, dealt with the cost of the project. H. Cimon, M.E.I.C., chairman of the Branch, presided and introduced the speaker.

Mr. Pratley dealt principally with the superstructure of the central portion, the suspension bridge, and with the anchor piers which were both important and somewhat unique. Slides were shown of studies for other types of span and the advantages of the suspension bridge were outlined. Reference was then made to the problems facing the designing engineer, such as the construction of anchorages in tidal waters, the choice of material, the selection of floor detail, the appearance of the towers, the mathematical determination of the dimensions of the stiffening trusses and so forth. The speaker went on to illustrate the construction of the anchor-piers, and views of the building procedure, and the insertion of the steel anchor-girders were shown. He then dealt with the specification, design and testing of the cables, and reference was made to the process of prestressing to which all cable-strands and hanger-ropes were submitted. The build-up of the main cables which support the roadway floor and also the detail manner in which these cables are anchored into the piers was shown by slides, and Mr. Pratley pointed out several entirely new features. Following this the design and erection of the towers was referred to, and the stringing of temporary walk-ways upon which to lay the main cables. This was followed by views of the methods by which the cables were hauled over, attached to their anchorages and adjusted for correct sag. The assembling of the individual strands, thirty-seven of which formed one cable, was also indicated by the slides and the final process of wrapping the cable with a wire covering which has not yet been undertaken at the side was illustrated by the exhibition of the same process being carried on at Grand'Mere six or seven years ago.

The lifting of the truss sections from the ice was the next feature dealt with, and was followed by references to the concrete-filled steel grid decking also new in this structure.

The construction programme calls for completion this summer, and it is expected that the bridge will be open to traffic by Dominion Day.

Saskatchewan Branch

S. Young, A.M.E.I.C., Secretary-Treasurer.

Eighteenth Annual Meeting

The eighteenth annual meeting of the Saskatchewan Branch of The Institute was held in the Parliament Buildings, Regina, commencing at 8.00 p.m. on Friday evening, March 22nd, 1935. The meeting was preceded by a dinner at 6.30 p.m., the total attendance being fifty. Previous to the dinner the majority of those attending met in contest at curling, 12 rinks taking part.

Professor R. A. Spencer, A.M.E.I.C., of the staff of the University of Saskatchewan, Branch chairman, spoke briefly at dinner on engineering education. The business session was conducted by the vice-chairman A. P. Linton, A.M.E.I.C.

S. J. Swayze, accompanied by R. Pym, contributed two songs which were heartily applauded.

The report of the executive covering its activities during the past year, the report of the auditors, presented by R. W. Allen, A.M.E.I.C., and the report of the Papers and Library committee, presented by S. R. Muirhead, A.M.E.I.C., were adopted.

Mr. Muirhead announced that the next meeting would be in the Hotel Champlain, Regina, on April 8th, 1935, when H. N. MacPherson, A.M.E.I.C., would address the Branch on "The Preservation of Timber." Mr. Muirhead also gave a brief résumé of the contents of the February and March numbers of The Journal.

H. R. MacKenzie, A.M.E.I.C., reported for the committee on unemployment outlining verbally the activities of the committee during the past year.

The report of the Saskatoon Section read by the secretary on behalf of Professor Spencer was adopted. In the discussion consequent to this report attention was drawn to the possibility of including Prince Albert in the Saskatoon Section.

H. R. MacKenzie then informed the meeting of the action recently taken at the annual meeting of the Association of Professional Engineers with respect to the consolidation of the engineering profession throughout Canada, requesting similar action by this Branch of The Institute. Moved by H. R. MacKenzie, seconded by D. A. R. McCannel, M.E.I.C., and carried that, "this Branch of The Engineering Institute of Canada in annual meeting assembled hereby goes on record as being in favour of the consolidation of the engineering profession in Canada."

As a step towards consolidation Mr. McCannel then explained the desirability of having one person as secretary for the association and the Branch, but in order to facilitate the appointment of such a person it would be necessary to amend the Branch by-laws in accordance with the notice of motion sent out with the notice of the annual meeting.

H. R. MacKenzie raised the question of supporting the proposed action of the Association of Professional Engineers towards a meeting of all engineers in the province, probably in October or November of this year; moved by H. R. MacKenzie, seconded by H. C. Ritchie, A.M.E.I.C., and carried that this Branch of The Institute endorse the action of the Association of Professional Engineers recently taken at the annual meeting towards a general meeting of all engineers in the Province.

The speaker of the evening, E. E. Lord, A.M.E.I.C., was then introduced by the chairman, the subject of his address being "River Improvement Work in Manchuria."

Mr. Lord, who for ten years after the close of the Great War was assistant chief engineer on river improvement work at the mouth of the Liao river, confined his remarks to this project. The mouth of the Liao river, long in use for navigation purposes, became subject to heavy silting by reason of a diversion of part of the discharge. The preliminary work consisted of the making of a proper survey by triangulation to embrace a network suited to the taking of soundings.

The improvement work consisted in the first instance of the erection of a wall 36,000 feet in length for the purpose of directing the stream flow and confining it to a limited waterway thus increasing the rate of flow and thereby reducing the tendency to silt. The wall, erected two feet above low water mark, of loose rubble placed from scows, contained in excess of 500,000 cubic yards at a cost of approximately $2.00 per cubic yard. The work, including the driving of piles, was carried on without the use of machinery there being no power equipment, only hand labour—all concrete being hand mixed.

The cost of the work was paid by the Chinese government out of a tax on shipping.

Mr. Lord's address was provocative of considerable discussion after which a hearty vote of thanks was tendered the speaker.

The Preservation of Timber

The Saskatchewan Branch, Engineering Institute of Canada, met in regular session at the Hotel Champlain, Regina, on April 8th, 1935, being preceded by a dinner at 6.30 p.m. at which the attendance was thirty-one.

The chairman, A. P. Linton, M.E.I.C., introduced the speaker of the evening, H. N. MacPherson, A.M.E.I.C., consulting engineer, Vancouver, now specializing in the field of timber preservation, a former highly esteemed member of the Saskatchewan Branch, his subject being "The Preservation of Timber."

Mr. MacPherson, after outlining the various types of deterioration to which timber in use is subjected, gave an historical outline of development of methods of timber preservation followed by descriptions of modern methods of timber treatment, illustrating his subject with two reels of moving pictures.

The address was provocative of interested discussion whereupon a hearty vote of thanks was tendered the speaker.

The scrutineers reported the ballot on by-law amendments and the chairman declared the amendments duly carried, following which the meeting adjourned.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Items of Interest in Aviation

About sixty engineers were present at the Branch meeting of March 21st, 1935, to hear Mr. J. C. Uhlman, of the Manitoba Government Air Services, present a paper on "Items of Interest in Aviation."

Mr. Uhlman said that any reaction of the public against air transportation was generally based on one or more of three main causes—fear, cost, or lack of comfort. Fear was usually greatly alleviated after taking one air trip. Cost now compares very favourably with that of surface transportation, and is reduced as further advantage is taken of air services. The comfort is now comparable with that of bus transportation, except possibly for noise and 'bumpy' air.

The greatest remaining hazards of civil flying are conditions cutting off visibility and causing ice to form on the wings. Instrument flying is not difficult particularly if beam radio is used, but landing blind is a problem. One system which has been developed to allow this, depends on the detection by the pilot of intersections of a radio beam inclined slightly above the horizontal, with two vertical radio beams, one near the edge of the landing field, and the second two miles distant.

Variable pitch propellers have been a great advance. These are made adjustable at the will of the pilot, or are made automatically adjustable, control being dependent on the amount of thrust on the revolving blade.

Engine weight has been reduced to the place where, in the larger sizes, it amounts to only 1.34 pounds per horsepower, and in the smaller sizes, 1.6 pounds per horsepower.

In regard to the future, Mr. Uhlman pointed out that in 1934 the French had flown the south Atlantic seventeen times, and the Germans thirty-two.

The Manitoba Government Air Service, organized in 1932, had since that date flown the equivalent of six times around the world without a single accident to passengers or personnel.

The vote of thanks to Mr. Uhlman proposed by D. L. McLean, A.M.E.I.C., was heartily endorsed by all present.

Protective Relays

On April 4th, 1935, H. L. Briggs, A.M.E.I.C., relay engineer, Winnipeg Hydro-Electric System, addressed the Branch on the subject "Protective Relays, the Watch Dogs of a Power System."

The speaker emphasized that in spite of the best of operation and maintenance of an electric power system, electrical faults do occur. Among the tables showing causes of faults was the following, showing the summary of four years of operation of 495 miles of 66 kv. isolated neutral transmission circuits.

66,000 Volt Short Circuits

Cause	Number of troubles	Per cent
Lightning	22	29.7
Insulator failures	10	13.5
Large birds	15	20.3
Sleet	8	10.8
Miscellaneous	12	16.2
Unknown	7	9.5
	74	100.0

The function of protective relays was to cause the quick isolation of such faults, thereby limiting the damage at the point of the fault, and limiting the effects on the remainder of the power system. A number of principles of relay operation were described, and several schemes illustrated whereby difficult protection problems on the 66 kv. system of the Hydro were solved.

Where the question of electrical stability between power plants or loads was concerned, the tremendous economic importance of high speed clearance of faults was exemplified. A number of slides showing modern high speed (less than 1/30 second to operate) relays of various types were shown.

The vote of thanks to the speaker was tendered by Dean E. P. Featherstonhaugh, M.E.I.C., after which all present enjoyed cake and coffee.

1935 Annual Meeting of the Canadian Institute of Mining and Metallurgy at Winnipeg

The Engineering Institute of Canada was represented at the annual meeting of the Canadian Institute of Mining and Metallurgy held at Winnipeg on March 12th, 13th and 14th, 1935, by E. V. Caton, M.E.I.C., vice-president of The Institute, and Fred V. Seibert, M.E.I.C., chairman of the Winnipeg Branch, and a large number of the local members of The Institute. Many papers of interest to members of The Institute were delivered.

The announcement of the presentation of the Leonard Medal to D. E. Keeley, McIntyre-Porcupine Mines, Schumacher, Ont., was also made. This medal was awarded by the late Colonel R. W. Leonard, M.E.I.C., past-president of The Institute, for the best paper published in the transactions of either The Engineering Institute of Canada or the Canadian Institute of Mining and Metallurgy, by a member of either organization. The subject of Mr. Keeley's paper was "Guniting at the McIntyre."

Errata

Errata in the discussion on "The English Bay Interceptor, Vancouver," by G. M. Gilbert, A.M.E.I.C., which appeared in the March 1935 issue of The Journal: In the discussion by J. M. Begg, M.E.I.C., instead of "design was based on an estimate of the flow of sewage for the maximum hour of the minimum day" read "the maximum hour of the maximum day" and instead of "in the repair shop" read "in the repair work."

In the review of "An Introduction to Structural Theory and Design" by Sutherland and Bowman, published by John Wiley and Sons, appearing on page 237 of the April issue of The Journal, the phrase appearing in the fifth paragraph as "With the Cross method of moment distribution now available, which greatly simplified the *layout*," should read "With the Cross method of moment distribution now available, which greatly simplified the *labour*."

R. S. Stockton, M.E.I.C., Superintendent, Operation and Maintenance, Western Section, Irrigation System, Canadian Pacific Railway Department of Natural Resoures, Strathmore, Alta., was stated incorrectly on page 231 of the April, 1935, issue of The Journal, to be manager of the Canadian Pacific Railway Experimental Farm at Strathmore.

Annual Meeting, Corporation of Professional Engineers of the Province of Quebec

Dr. A. R. Decary, M.E.I.C., superintendent engineer for the Province of Quebec in the Department of Public Works of Canada, was re-elected president of the Corporation of Professional Engineers of Quebec for the sixteenth time on Wednesday, March 27th, 1935, at the annual meeting of the Corporation held at the Headquarters of The Engineering Institute of Canada, Montreal.

The reports of Council and of the various committees showed great activity within the Corporation.

The report of Council mentions that the Corporation has succeeded in having certain laws amended at the last session of the Quebec Legislature, i.e., the Stationary Enginemen's Act, the Quebec Mining Act, the Quebec Insurance Companies Act respecting adjustment of claims.

The Committee on Affiliation with The Engineering Institute of Canada reported that the Corporation is ready and willing to co-operate immediately with the other provincial engineering organizations in an attempt to develop with The Engineering Institute a suitable and adequate basis of co-ordination of the engineering profession in the Dominion, and that the lines along which such co-ordination should proceed should be generally similar to those which have governed the organization of sister professions in Canada.

The Committee on Publicity recommended that special attention be given to publicity relating to the usefulness and the importance of the engineering profession to the public.

The committee nominated to study the proposed N.R.A. Code for engineers of the United States considered that said code covers the complete field of the practice of engineering in a most comprehensive and practical manner, and suggested that the by-laws and code of ethics of the Corporation be altered along the lines of the N.R.A. code wherever possible.

Immediately after the meeting the Council met and elected the following officers: President, Dr. A. R. Decary, M.E.I.C.; vice-president, Mr. J. M. Robertson, M.E.I.C.; Honorary Secretary-Treasurer, Mr. S. F. Rutherford, A.M.E.I.C. The other members of Council are: Dr. O. O. Lefebvre, M.E.I.C., Colonel C. N. Monsarrat, M.E.I.C., and Messrs. A. B. Normandin, M.E.I.C., Geo. K. McDougall, M.E.I.C., and Hector Cimon, M.E.I.C. Mr. Adhemar Mailhiot, M.E.I.C., was re-elected Registrar of the Corporation.

List of New and Revised British Standard Specifications

(issued during February, 1935)

B.S.S. No.

32—1935. *Steel bars for the Production of Machined Parts for General Engineering Purposes. (Revision.)*
Withdrawal of Grade 3—free cutting steel for repetition work—and inclusion of a Grade 4 for rapid machining steel for repetition work which has superior shock resistance to the former Grade 3.

140—1935. *Liquid Starters and Controllers for the Rotor Circuits of Induction Electric Motors. (Revision.)*
Provides for standard ratings and sizes, general features of design and construction, etc. Includes appendices on estimation of capacity.

232—1935. *Vitreous-Enamelled Steel Reflectors for Electric Lighting. Open Dispersive Type No. 1. (Revision.)*
Deals with vitreous-enamelled steel reflectors for direct general lighting (open dispersive type) which are designated according to the nominal consumption of the gas-filled lamps for which each is suitable.

587—1935. *Motor Starters and Controllers (Excluding Liquid Starters and Controllers and Single-Phase A.C. Models).*
Revised specification, which supersedes the undermentioned, provides for standard ratings and sizes, etc., and includes detailed appendices on terminal markings.
(Superseded B.S.S. Nos.:—
117—1923. Drum Starters; 118—1923. Drum Controllers and Resistances; 123—1923. Face-Plate Controllers and Resistances; 129—1923. Contactor Controllers and Resistances; 141—1923. Switch Starters; 147—1923. Multiple Switch Starters; 155—1923. Contactor Starters; 167—1923. Auto-Transformer Starters; 246—1927. Face-plate Starters (D.C.); 247—1927. Face-plate Rotor Starters.)

588—1935. *Grading of Plywood (Veneered with Oak, Mahogany, Walnut, Teak and other Ornamental Woods).*
This standard forms the second of a series for commercial plywoods and includes definitions, general clauses and four simple grades.

589—1935. *Nomenclature of Softwoods (Including Botanical Species and Sources of Supply).*
Includes over seventy (70) trade names as well as botanical country of origin and synonyms in common use.

Obtainable from the British Standards Institution, Publications Department, 28, Victoria Street, S.W.1, and from Canadian Engineering Standards Association, Sussex Street, Ottawa, Ont.

The Laws of a Mass of Clay Under Pressure

M. A. Ravenor, M.E.I.C., M. Inst.C.E.

Abstract from Sessional Notice No. 3, February, 1935, of the Institution of Civil Engineers.

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Engineers have been in the habit of referring to the capacity of a soil to carry so many tons per unit area without regard to the corresponding amount of settlement, whereas it is an accepted principle in the testing of engineering materials that stress is accompanied by a corresponding deformation. A knowledge of the behaviour of clay under pressure would permit greater loads to be used. Millions of pounds are expended annually upon the foundations of all kinds of structures, a considerable part of that cost being incurred, of necessity, to allow for the uncertainty of design due to an almost entire lack of knowledge of the subject.

The author has made a prolonged study of the problem of a large mass of clay subjected to the pressure of a finite area; he has conducted a large number of tests on clay, and has been able to reconcile their results with the actual settlement of structures erected in the same clay. The laws which have been deduced from the tests confirm experiments which have been made by other investigators. In particular, the author's law of induration not only fills the gap between Professor Rankine's and Mr. A. L. Bell's[1] formulae, but it gives the intensity of the load in terms of settlement, and, indirectly, in terms of depth and water content. The large divergence from Rankine's formula is shown to be due mainly to compression or induration of the material. In other respects the author confirms the work of Professors Ackerman and Terzaghi, Dr. Faber, and others, which gives added confidence and assists in co-ordinating the stages through which a mass of clay under pressure passes.

It is an accepted principle that the testing of an engineering material should emulate, as closely as possible, the conditions to which it is subjected in use. For this reason it is considered that the most reliable method of testing the resistance of clay is by the slow penetration of a loaded plunger.

Earlier experimenters have, generally speaking, aimed at the discovery of a single law which clay under pressure would obey; no previous investigator appears to have found that clay under test passes through the elastic, ductile and plastic stages, although it should be stated that such an analogy has been suggested, but the author shows that the analogy of clay and such metals as steel, copper, etc., is striking. He attributes his more satisfactory results largely to the development of a method of testing explained in the paper, which measures the reaction of a mass of clay to the pressure of a finite area more accurately than has been possible hitherto.

From the foundation-engineer's viewpoint, clay should be considered as a porous, permeable and compressible mass, composed of fine grains of clay matter which are surrounded by a "lubricant" consisting of water and colloid matter; its physical properties are thus remote from those of the ideal material assumed by Rankine. Mr. Berridge[2] has pointed out that clay has a maximum water-content consistent with the pressure and with its colloid-content. The principal effect of extraneous pressure is to change its physical properties within a limiting zone.

Law of Induration.—When an extensive mass of clay *whose resistance to compression is less than its resistance to motion* is subjected to the pressure of a finite area, the material undergoes physical changes comprising the process of induration, and resulting in a change in water content, compression (closer aggregation of grains), a change in texture, and an increase in strength (cohesion). The direct result of these changes is the development of a compressed area or "bulb" whose effective area increases towards a maximum with increase of pressure. From a large number of tests made by the author and also by other investigators, the relation of load and deformation, during this stage, is found to be represented by the equation:

$$C = \left(\frac{P}{m} + I\right)^6,$$

where C denotes the deformation or settlement of the loaded area in ins.
P " the intensity of the load in lbs. per sq. ft.
I " a constant, representing elastic deformation in ins.
m " a coefficient which depends for its value upon the water-content and extent of the area as described.

The author investigated the process of induration described by an examination and analysis of material after conducting tests which showed the physical changes referred to. Dr. Faber's[3] demonstration of a maximum stress at the outer edge of the loaded area is consistent with the formation of the bulb described, and comparative results are given.

The influence of water-content is dealt with, also the effect of varying load-increment and of different areas experimented upon up to 10 inches diameter and at depths up to 15 feet. For a constant settlement the general equation given above becomes a straight-line law connecting the load and the area, as already shown by Mr. W. S. Housel.[4]

A comparison is made with Rankine's and Bell's formulae. By assuming a constant settlement for a given area, the general equation becomes a linear relation between load and depth, as shown by Mr. Bell's formula, but the location of this straight line in relation to the axes is shown to vary according to the amount of settlement assumed. Rankine's formula may be said to be based on the hydraulic analogy, and it can be shown that the only difference between his formula and Bell's is in the intercept on the load axis. In dealing with a compressible material it will be appreciated that its resistance to compression may be less than its resistance to motion or displacement, and in the case of clay this is always so until the condition of a liquid mud is approached. For an infinite area, however, the resistance of clay to compression cannot be less than that represented by its unit weight multiplied by the depth, as the material will have been compressed by its own superincumbent weight.

The relation of test results to the settlement of structures erected in the same clay is shown; the author considers that it is now possible, by making tests at the site of the proposed works, to determine with reasonable certainty the permissible load corresponding to a given settlement.

[1]Minutes of Proceedings Inst. C.E., vol. cxcix, pp. 233 *et seq.*
[2]*Engineering*, July, 1930, p. 5.
[3]Journ. Inst. Struct. Engrs., p. 116, vol. xi (1933).
[4]Dept. of Research, University of Michigan October, 1929.

Submergible Road Bridge Near Jubbulpore, India

This bridge over the Nerbudda replaces a ferry in the rains and a temporary wooden erection for the rest of the year, and has at last made possible practically uninterrupted road communication between Nagpur and Jubbulpore. Ever since the British occupation of this part of India, this road, 165 miles long, has been of outstanding importance for both the civil and military administrations, and it was macadamized throughout at an early date, every river and stream being bridged, except the Nerbudda. The serious technical difficulties involved in bridging this river prevented the work being undertaken until quite recently. Ultimately, a design for a submergible bridge, a type largely developed in the central provinces, was made, and work was started in February, 1929.

The type of bridge adopted is called submergible because it is definitely designed to be overtopped, without suffering any serious damage, by the occasional very high flood, such as that in 1926, which completely washed away both the adjacent railway bridges, but it will pass all but the highest floods of a normal season. This type is thus more economical than a high-level bridge for rivers subject to such extremely high floods as the Nerbudda, the maximum flood rise of which is 78 feet. Although, being built deliberately to allow the highest of the annual, as well as the exceptional, floods to pass over them, such bridges have to be extremely massive in construction to withstand uplift, overturning and the buffeting from huge logs brought down in flood-time, nevertheless they effect a considerable saving of cost, even over a high-level bridge of much lighter construction, owing to the reduced height of piers, abutments and approach banking. There is the further extremely important advantage that, if the bridge has been correctly designed and properly constructed, it will reappear undamaged, or at worst but slightly damaged, after submergence by any flood, however exceptional, whereas a high-level bridge, if overtopped, is almost certain to be completely destroyed.

The determination of the formation-level, to give the most useful service and yet permit of the greatest economy, is effected by keeping a record over a series of years of the rise and fall of the river at the site selected. These records, when plotted, make it possible to choose a formation-level which will ensure that in a normal year the bridge is only overtopped on some three or four occasions during the monsoon, and for a maximum period at any one occasion of about twenty-four hours only. In this case, the formation-level actually selected was 40 feet above the lowest bed-level of the river.

The bridge consists of eight arches of 46-foot clear span, five at one end and three at the other, and six spans of 98 feet in the central length; including abutments and wings, the overall length is 1,222 feet. The roadway is 21 feet wide, paved with blocks of hard red sandstone, and traffic is protected by a special form of collapsible railing, which can be rapidly let down into slots in the bed of the roadway, so as to avoid damage in a high flood. This paved roadway is level over the central length of the bridge, and has a slope of 1 in 25 at each end to conform with the slope of the approach cutting. The lengths between the level and sloping portions follow carefully calculated vertical curves to ensure fast traffic passing without any jolt.

The piers, except three at the centre, are of stone masonry with a concrete hearting, founded on rock. The three central piers are similar, but are founded on a reinforced-concrete slab 2 feet thick, supported by forty-six reinforced-concrete piles, 14 inches square, driven to an average penetration of 18 inches into rock. All the piers had twelve steel 90-pound rails embedded in them from rock-level (or slab-level in the case of those on pile foundations) up to well into the arches, to the reinforcement of which they were tied, making the whole bridge effectively monolithic in its resistance to buoyancy and overturning.—Mr. A. W. H. Dean in *Engineering.*

The Dominion Bridge Company Limited have completed arrangements with The Wellman Engineering Company of Cleveland giving the Dominion Bridge Company Limited rights for the manufacture and sale of "Williams" buckets in Canada.

Preliminary Notice

of Applications for Admission and for Transfer

April 29th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in June, 1935.

R. J. Durley, Secretary.

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*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

> The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

ATTENBOROUGH—ERNEST ARTHUR, of 72 East Lynn Ave., Toronto, Ont., Born at Toronto, July 13th, 1913; Educ., Ontario Matriculation. Evening course, app. mechs. and strength of materials; 1930 to date, tracer, sewer dfting. office, Dept. of Works, City of Toronto.
References: F. J. Hancox, G. Phelps, T. Taylor, A. U. Sanderson, G. G. Powell.

DAVIS—WILLIAM ROE, Jr., of Calgary, Alta., Born at Calgary, June 28th, 1909; Educ., B.Sc. (E.E.), Univ. of Alta., 1934; 1928-30, and at present, asst. engr., Calgary Power Co., Calgary, Alta.
References: G. H. Thompson, H. B. Sherman, H. B. LeBourveau, H. J. MacLeod, J. H. Ross.

EVANS—THOMAS OWEN, of St. Vincent de Paul, Que., Born at Montreal, Jan. 31st, 1905; Educ., B.Sc., McGill Univ., 1927; With Montreal Light, Heat & Power Cons., as follows: Summers 1923-24, and May 1925 to Oct. 1926, at Cedars plant, floorman, asst. operator and operator in transformer house. 1927-29, at Montreal, ap'tice. engr., operating and mtce. substations; cable gang; layout work in distribution dept.; 1930 to date, asst. supt., Back River plant, Montreal Island Power Co., St. Vincent de Paul, Que.
References: R. N. Coke, G. P. Hawley, L. H. Marrotte, M. V. Sauer, J. F. Roberts.

HALLE—CHARLES JULES, of 61 de Repentigny, Quebec, Que., Born at St. Lambert, Que., July 8th, 1901; Educ., 1923-26, Ecole de Génie Civil, Paris. R.P.E., Quebec, 1927; 1927 to date, professor, Quebec Technical School, maths., app. mechs., strength of materials, etc. Also consltg. engr., reinforced concrete structures.
References: A. Frigon, P. Methe, J. H. A. E. Drolet, A. V. Dumas.

HAMILTON—VESEY COURTHOPE, of Exshaw, Alta., Born at Sterling, Ont., Jan. 10th, 1903; Educ., Grad., R.M.C., 1924; 1924-27, timber cruising, surveying, logging, with Price Bros. & Co. Ltd., Chicoutimi, Que.; 1929-30, supt., National Cement Co. Ltd., Montreal; With Canada Cement Co. Ltd., as follows: 1927-28, asst. engr., constrn., Lakefield, Ont., 1929, asst. supt., Exshaw, Alta., 1930-33, supt., Winnipeg, 1933 to date, supt., in charge of plant at Exshaw, Alta.
References: S. Barr, J. A. Creaser, L. F. Grant, F. B. Kilbourn, H. J. McLean, R. S. Trowsdale.

HUDSON—ARTHUR MAGENISS, of Toronto, Ont., Born at Norwich, England, July 11th, 1889; Educ., 1904-07, articled to Duge & Son, Norwich, gen. engrg. work, principally bldgs.; 1908-09, levelman, C.N.R. constrn.; 1909-10, levelman, Algoma Eastern Rly. constrn.; 1910-12, foreman and supt., for Roger Miller & Sons, and 1912-15, administrative engrg. for same company; 1915-17, overseas, Capt., C.E.F.; 1917-19, res. engr. in charge of aerodrome constrn., British War Office; 1920-27, suptg. and administrative engr., principally design and set-up of equipment, Roger Miller & Sons; 1927-33, with Canadian Ingersoll Rand Co., specializing on the application of pneumatic tools for rock-mining and general contract work; 1934 to date, equipment engr., Dept. of Northern Development, Ontario Government, covering equipment and its application to road constrn., also engrg. costs of gen. mtce.
References: G. W. Rayner, E. L. Cousins, F. R. Phillips, T. F. Francis, W. H. Greene, W. E. Bonn.

KING—JOHN DAVID, of Montreal, Que., Born at Chatham, Ont., July 19th, 1895; Educ., B.Sc. (Loyola College), 1916. 1916-22, Faculty of Engrg., McGill Univ., (did not complete course); 1920, elect'l. work at Franklin, Que.; 1922-28, radio and electrical work; 1928-29, combustion work, and 1929-32, mgr., Riley Engineering & Supply Co. in Quebec; 1932-35, sales engr., Minneapolis Honeywell Regulator Co., Montreal, Que.; At present, mgr., Detroit Stoker Company of Canada Ltd., Montreal, Que.
References: F. S. B. Heward, F. A. Combe, E. A. Ryan, G. L. Wiggs, A. Wilson, J. A. Kearns, H. C. Karn, D. F. Grahame.

KITCHEN—ISAAC, of Raymond, Alta., Born at Manchester, England, Oct. 13th, 1896; Educ., I.C.S. elect'l. engrg. course; 1913-14, electrn.'s helper; 1914-19, Canadian Signals, C.E.F.; 1919-22, ap'tice., 1922-25, plant inspr., 1925-27, exchange sub-foreman, Alberta Govt. Telephones; 1927-28, elect'l. contracting, Medicine Hat, Alta., light and power installns. at the Medicine Hat Brick & Tile Co., Mid-Alta. Potteries, Ltd., Alberta Clay Products, Ltd., Ogilvie Milling Co. Ltd.; 1929, erection dept., Can. Gen. Elec. Co., switchboard installns. at the East Kootenay Power Co.'s plant at Sentinal, B.C., and City of Nelson plant at Bonnington Falls. Motor installn., Manitoba Rolling Mills, Calgary; 1929-32, chief electrn., Manitoba Rolling Mills, Ltd., Calgary; 1933 to date, chief electrn., Canadian Sugar Factories Ltd., Raymond, Que.
References: J. Dow, R. S. Trowsdale, P. F. Peele, G. E. Elkington, F. McLeod.

McINTYRE—WALTER BAKER, of 173 Peter St., Port Arthur, Ont., Born at McCreary, Man., May 9th, 1904; Educ., Night Classes, Kelvin Technical School, 1920-24. 1925-26, private tuition; with C.N.R. as follows: 1920-27, chainman, rodman, levelman; 1927 to date, instr'man. and asst. engr. In charge of all field work including various location and revision projects, rebldg. of terminal yards (1928-29), constrn. of bldgs., water supply, etc. In charge of rly. constrn. job let by contract (1929-30).
References: H. A. Dixon, W. T. Moodie, W. Walkden, E. R. Millidge, J. W. Porter, V. C. Hooper, G. H. Burbidge, P. E. Doncaster.

NELSON—EDWARD, of Edmonton, Alta., Born at Teddington, Middlesex, England, July 26th, 1885; Educ., Private study. R.P.E. Alta.; 1914-19, asst. and transitman on Dominion land surveys; 1920-23, senior engrg. clerk, irrigation divn., Dept. Interior, Calgary; 1923, private surveys, drainage; 1924 to date, engr. in charge, surveying, design, plans, laying out, reports, statistics, etc., of natural gas properties, measurement of gas, for Northwestern Utilities Ltd., Edmonton, Alta.
References: R. S. L. Wilson, C. E. Garnett, F. J. Heuperman, J. Garrett, F. K. Beach, R. J. Gibb, A. W. Haddow, R. M. Dingwall.

ROUSSEAU—GABRIEL EUGENE, of Montreal, Que., Born at Montreal, April 27th, 1903; Educ., 3 years, Ecole Polytechnique, Montreal. B.Sc., in Elec. Engr., Mass. Inst. Tech., 1925; 1920-25, summer work with the Montmagny Power Co., and 1925-26, engr. with same company; 1926-27, engr., Electrical Mfg. Co. Ltd.; 1927-29, asst. supt., A. Belanger Ltee.; 1929-34, professor, Montreal Technical School; 1931 to date, asst. to the Director General of Technical Education, Province of Quebec, and from 1934 to date, also lecturer and asst. to the Dean, Ecole Polytechnique, Montreal, Que.
References: A. Frigon, J. T. Lafreniere, J. A. Lalonde, A. Duperron, V. Toupin.

SHAW—PHILIP, of Prince Albert, Sask., Born at Huddersfield, England, May 1st, 1895; Educ., Private tuition. B.C. Land Surveyor; 1919-22, articled pupil, and 1920-24, instr'man. and junior engr. on irrigation and reservoir surveys and constrn., F. W. Groves, M.E.I.C., and G. Stirling, M.E.I.C., Kelowna, B.C. 1925-31, junior engr., and 1931 to date, asst. engr., highway constrn., National Parks of Canada, Dept. of the Interior, Prince Albert, Sask.
References: F. W. Groves, G. Stirling, J. M. Wardle, J. N. Stinson.

SHELDEN—WILLIAM LESLIE, of 460 Avenue Road, Toronto, Ont., Born at Melbourne, Australia, April 30th, 1898; Educ., 1920-23 (full day course), Working Men's College of Melbourne, Australia. Diploma Elect'l. and Mech'l. Engrg. Granted certificate as "Associate" 1923; 1923-26 (night course), mech'l. engrg., Carnegie Institute of Technology, Pittsburgh, Pa.; 1917-19, Signal Engrs., Australian Imperial Forces; 1923-26, dftsman. and some design, control engrg. dept., Westinghouse Elec. & Mfg. Co., E. Pittsburgh; 1926 (3 mos.), dfting., pipe layout and design, The Koppers Co., Pittsburgh (coal by-product equipment); 1926 (3 mos.), design and layout of heating and ventilation, H. H. Angus, Consltg. Engr., Toronto; 1926-29, design and layout of hydro-electric and steam power plants for Brazil and Mexico, also 1929, engr. on design and specification, Canadian and General Finance Co., Toronto; 1931 to date, designing engr., water supply section, Dept. of Works, City of Toronto.

References: A. U. Sanderson, T. Taylor, J. F. MacLaren, R. L. Hearn, H. L. Dowling, J. A. Langford, A. Roberts.

SIMPSON—FREDERICK CRESWELL, of 7 Idyllwood Crescent, Toronto, Ont., Born at Aberdeen, Scotland, May 9th, 1897; Educ., 1919-20, Robert Gordon Technical College, Aberdeen, Scotland; 1913-14, commenced ap'ticeship with Pratt & Keith, Aberdeen; 1914-15, elect'l. work in Niagara Falls, Ont.; 1915-19, overseas, C.E.F.; 1921-22, with Herbert Morris Crane & Hoist Co. Ltd., as field engr. in western Ontario with responsibility for field measurements, layouts, recommendations, and supervision of complete installns.; 1922-23, elect'l. work in partnership with brother; 1924 to date, returned to Herbert Morris Crane & Hoist Co. Ltd., taking responsibility for a much larger territory extending to the province of Quebec and covering both Ontario and Quebec.

References: J. L. Miller, F. L. Haviland, C. G. Porter, J. B. Candlish, G. E. Newill.

TIMMINS—WILBUR W., of Montreal, Que., Born at Everett, Ont., Oct. 30th, 1899; Educ., B.A.Sc., Univ. of Toronto, 1923; 1923-24, dfting. and designing, and 1925-27, res. engr. in charge of constrn., James, Proctor & Redfern, Toronto; 1927-28, engrg. dept., at Chicago, Curtis Lighting Inc., and 1928-34, representative for Province of Quebec for same company (later Curtis Lighting of Canada); 1934 to date, in business for self as manufacturers' agent.

References: G. L. Wiggs, E. A. Ryan, F. J. Friedman, H. G. Thompson, W. J. Armstrong, J. A. Kearns, F. S. B. Heward.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

CROSS—EDGAR ALGERNON, of 25 Ferndale Ave., Toronto, Ont., Born at Petersfield, Hants., England, April 7th, 1889; Educ., B.Sc. (Civil), Birmingham Univ., 1909, 1910-15, asst engr., Birmingham, England, canal navigations, surveys, designs for canal works damaged by mining operations; 1915-17, attached to special brigade, Royal Engrs., France; 1917-19, research engr., Royal Arsenal, Woolwich; 1919-20, chief asst. engr., Birmingham, canal navigations; 1920-22, supt. of constrn. on following works for L. W. Stoddart, architect, New York City—mica insulating factory, Schenectady, Hotel Sheraton, High Point, N.C., Lycoming Hotel, Williamsport, Pa.; 1922-27, struct'l. engr., Albert Kahn, Detroit, Mich., design of reinforced concrete and struct'l. steel bldgs., industrial plants, etc.; 1927-30, struct'l. engr., Chapman & Oxley, Toronto, struct'l. design for Robert Simpson stores, Toronto and Montreal, and Yardley Bldg., Toronto; 1930 to date, consltg. struct'l. engr., private practice, structural designs, appraisals, reports, Toronto, Ont. (*A.M. 1925.*)

References: A. L. Birrell, R. A. Crysler, J. Hole, J. M. Oxley, R. E. Smythe.

GARRETT—JULIAN, of Edmonton, Alta., Born at Hyde Park, Mass., Jan. 8th, 1883; Educ., 1900-04, Harvard College and Lawrence Scientific School (A.B.); 1903-04, asst. instructor, Harvard engrg. camp; 1905, instr'man., Norwood, Canton & Sharon Street Rly.; 1905-06, instr'man., G.T.P.Ry.; 1906, asst. engr., St. Louis Terminal Rly. Assn.; 1906-11, res. engr., G.T.P.Ry.; 1924-28, sec. treas., in charge of operation during absence of president, and from 1928 to date, manager (in charge of operation of entire natural gas system), Northwestern Utilities Ltd., Edmonton, Alta. (*A.M. 1907.*)

References: H. J. MacLeod, A. W. Haddow, R. W. Ross, C. E. Garnett, F. K. Beach.

FOR TRANSFER FROM THE CLASS OF JUNIOR

SHUTTLEWORTH—WILBUR IRVIN, of 192 James St., Ottawa, Ont., Born at Ottawa, Oct. 4th, 1901; Educ., Passed Institute's exams. Schedule "B" (1932) and Schedule "C" (1933); 1922-26, instr'man and asst. engr., Geodetic Survey; 1926-27, instr'man., Gatineau Power Co.; 1929 (Apr.-Sept.), res. engr., Foundation Co., at Dalhousie, N.B.; 1929-30, engr. on addition to ground wood mill and hydraulic plant for Jas. MacLaren Co., Buckingham, Que.; 1930-31, engr. at Lucerne in Quebec, on hotel and bldgs., also water main, dam and pumping station; 1931 (Aug.-Dec.), engr. at Masson, for Foundation Co.; 1932 (June-Dec.), engr. for L. G. Ogilvie Co., on a high school in Verdun, Que.; Nov. 1933 to date, instr'man., sewer branch, engrg. dept., City of Ottawa. Giving line and grade for all open cut sewers, checking line and grade in tunnels, also some dfting. (*Jr. 1932.*)

References: W. F. M. Bryce, B. R. Perry, D. DeL. French, H. V. Serson, W. E. Blue, D. McMillan, J. H. Irvine, N. J. Ogilvie, C. D. Wight, F. B. Reid.

FOR TRANSFER FROM THE CLASS OF STUDENT

BUTLER—HOWARD CLAUDE, of 621 Milton St., Montreal, Que., Born at Ottawa, Ont., March 4th, 1906; Educ., B.Sc. (Mech.), McGill Univ., 1930; Summer work while attending McGill: telegraph line constrn., C.P.R., rodman and dftsman., C.P.R., Ottawa divn.; 1930-31, engrg. dftsman., and later asst. to plant engr., and from 1932 to date, asst. to chief engr., Dominion Rubber Co. Ltd., Montreal, Que. (*St. 1930.*)

References: R. Ford, J. L. Busfield, E. R. Smallhorn, C. O. Thomas, W. W. Benny.

SEELY—WALLACE ERROL, of Montreal, Que., Born at Saint John, N.B., March 19th, 1906; Educ., B.Sc. (C.E.), Univ. of N.B., 1930; 1926-27-28, (summers), chainman on govt. property line survey, compassman, lumber survey, winder, C.G.E., Grand Falls, N.B.; 1929 (June-Nov.), concrete inspr., James MacLaren Co., Buckingham, Que.; 1930, struct'l. detailer, Dominion Bridge Co., Lachine; 1930-31, bldg. inspr., C.N.R., Montreal; 1931, pile inspr. and sheet steel estimator, Saint John Harbour reconstrn.; 1934 (July-Nov.), chemical operator, Canadian Industries Ltd., Shawinigan Falls, Que.; 1934-35, elect'l. helper, Fraser-Brace Co. Ltd., Shawinigan Falls, Que. (*St. 1929.*)

References: J. Stephens, E. O. Turner, J. A. W. Waring, W. J. Johnston, A. F. Baird.

Glare from Motor-Car Headlights

A frequent cause of accident, not only to those most intimately concerned but to other road users, is glare from the headlights of one car dazzling the driver of another coming in the opposite direction. This risk is not removed by extinguishing the headlights of one or both cars and, though many anti-dazzle devices have been proposed, their relative efficiency yet remains to be determined. This arises from the fact that glare is due to a variety of causes; and that any attempt to assess the efficiency of a proposed system by direct trial is greatly hampered by their interplay under practical conditions. It is therefore primarily necessary to make a scientific analysis of these contributory factors.

A report, recently issued by the Department of Scientific and Industrial Research, is intended to provide one way of making such approach. It defines glare as being the reduction in the driver's power to detect objects ahead of him in the roadway and describes a method of estimating its effect on a driver when the oncoming car is fitted with headlights whose light distribution is known. The principal factors, which determine the amount of the reduction are the candle-power of the approaching headlight in the direction of the observing driver's eye, the relative positions of the two cars and the object to be detected, the reflection factors of this object and of the road surface and the speed at which the cars are approaching each other.

The visibility of an object can be stated as the ratio of the brightness difference to the brightness difference threshold. The former quantity is the difference between the brightness of the object, as seen by the driver, and of the road or sky immediately surrounding it. It may be either positive or negative and will be perceptible if it exceeds the smallest perceptible brightness difference or brightness threshold. In absolute magnitude, irrespective of sign, this visibility must have a value considerably greater than unity, possibly as high as five before an object can be picked up by a driver with any degree of certainty. When the headlights of an approaching car appear in the field of view they generally bring about an increase in the brightness threshold, thus reducing the sensitivity of the eye and decreasing the visibility. This increase depends on the value which the brightness threshold assumes when the glare is removed, on the angles which the driver's direction of vision makes with the lines joining his eyes to the glaring headlights and on the illuminations in the plane of the driver's eyes, due to those headlights. Glare is completely specified by the two angles and the two illuminations, while the brightness threshold, for an object surrounded by a given brightness in the presence of a glare specified by these four qualities, has the same value as for an object surrounded by a second or equivalent brightness in the absence of glare.

Now the brightness difference, the field brightness, the eye illuminations and the angles of direction can all be determined when the positions of the two cars and of the object, the reflecting properties of the object and roadway and the light distributions in the headlight beams are known. Thus the visibility of the object, as reduced by glare, can be determined, though as a study of the report will show, a great deal of work is necessary for the attainment of this end.—*Engineering.*

Dr. M. I. Pupin Dead

Dr. Michael Idvorsky Pupin died in New York, N.Y., on March 12th, 1935, at the age of seventy-six. Dr. Pupin was born at Idvor, Banat, Hungary, on October 4th, 1854, and emigrated to New York in 1874 where by working during the daytime and studying at night he was able to enter Columbia University in 1879, obtaining a B.A. degree in 1883 and becoming a naturalized American citizen at the same time. He then returned to Europe, studying physics and mathematics at the Universities of Cambridge and Berlin, and obtaining a Ph.D. degree from the latter in 1889. Returning to America, he joined the staff of Columbia University, as instructor in mathematical physics, being appointed Adjunct Professor of Mechanics in 1892. In 1901 he was made Professor of Electromechanics, and two years later was appointed Director of the Phoenix Research Laboratory. He retained this position and his professorship until 1929, when he retired with the title of Emeritus Professor in Active Residence.

In addition to his invention of the loading coil for long-distance telephone cables he made many contributions to the advancement of scientific knowledge. For instance in 1896, he invented the method of increasing the rapidity of X-ray photography by placing a screen of fluorescent material between the object and the photographic plate. He also discovered secondary X-ray radiations and produced X-ray photographs for use as a guide to surgeons in operations. In 1899 he published his mathematical theory of artificial lines or networks, which has been widely applied since then, and, in 1902, he was granted a patent for tuned electrical circuits, the patent being acquired by the Marconi Company.

Dr. Pupin became president of the American Institute of Electrical Engineers in 1925, and was awarded the Edison Medal in 1920 and the John Fritz Medal in 1932. That the value of his work was recognized during his lifetime may be gathered from the numerous awards he received, both in the United States and in foreign countries.

Canadian Electrical Association Annual Convention

The forty-fifth annual convention of the Canadian Electrical Association Inc. will be held at the Algonquin Hotel, St. Andrews-by-the-Sea, N.B., on June 26th to 28th, 1935.

An interesting and instructive programme is being planned, which will include the regular business sessions, discussion of the various committee reports, and the presentation of several special papers which will be of interest and value to all.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

MECHANICAL ENGINEER, not over 45 years of age, with practical experience in machine shop practice to act as production engineer with large machinery manufacturing company. Location province of Quebec. Give full details of experience and personal qualifications to Box No. 1142-V.

CIVIL SERVICE OF CANADA
List No. 623

The Civil Service Commission announces an open competitive examination for the following position:

23953.—A Chief Operating Officer, Board of Railway Commissioners, at an initial salary of $4,800 per annum, subject to such deduction as may be provided for by legislation.

Duties.—Under the direction of the Board to administer the Operating Department of the Board of Railway Commissioners; to consider and report upon questions of operation, train rules, signals, train services, car supply, fire prevention regulations and safety appliances, including cars and locomotives and stationary and locomotive boilers; to direct the staff engaged upon inspection of safety appliances and railroad operation, and upon investigating all types of accident, personal injury or death in or from moving trains or complaints in respect to railroad services; to consider and report upon applications for abandonment of lines; to hold conferences of railway and employees' representatives on matters referred to the Board or arising out of the Department's work; to make investigations and reports as requested by the Board in any matter of railway operation; ou occasion to conduct personal investigations of accidents or complaints; and to perform other related work as required.

Qualifications Required.—Education equivalent to graduation from a university of recognized standing; at least ten years of experience in the operating department of a railway, at least five years of which shall have been in an administrative capacity or on equivalent regulatory work; thorough knowledge of general railway operation including train rules, signals and methods of fire prevention; familiarity with the mechanism, use and inspection of safety appliances required on railway operating equipment, including cars and locomotives, boilers and appurtenances, air brakes, crossing signals and other safety equipment; demonstrated administrative ability, tact, good judgment. Although no definite age limit has been stated, age may be a determining factor in making a selection.

Applicants must give full particulars concerning their technical training and experience, especially as they bear on the qualifications for and duties of this position. An oral examination may be given, if necessary in the opinion of the Commission.

An eligible list valid for one year may be established.

General Directions

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, **not later than May 23, 1935.** Application forms may be obtained from the offices of the Employment Service of Canada, from the Postmasters at any City Post Office, from the Secretary of the Civil Service Commission, Ottawa, or from The Engineering Institute of Canada, Montreal.

Candidates must be British subjects, and have resided in Canada for at least five years.

Situations Wanted

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.SC. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

Situations Wanted

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., JUN. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters of Branch secretaries.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

Situations Wanted

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W

ELECTRICAL ENGINEER, B.SC. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial Apply to Box. No 651-W.

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30 Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, JR.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

Situations Wanted

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W

CIVIL ENGINEER, B.A.Sc., JR E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W.

Situations Wanted

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.Sc., Queen's '33 Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Write and speak both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211 W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

COMBUSTION ENGINEER, A.M.E.I.C., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet and tissues. Apply to Box No. 1246-W.

CIVIL ENGINEER, B.Sc. '29, JR.E.I.C., age 29, single. Experience in all types of surveying including use of aerial photographs. Three years on hydro-electric power development in field and office. Instrumentman on concrete road construction. Location immaterial. Apply to Box No. 1254-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

INDUSTRIAL ENGINEER, B.Sc. in Mech. Eng (McGill '31), Rockefeller Research Associate in industrial engineering on economic and statistical analysis. Previous experience in manufacturing plants. Desires connection with industrial firm. Apply to Box No. 1269-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '29) Age 28. Six years experience in automobile office and plant; two years as supervisor of inspection in body assembly. Good understanding of modern business methods applied to manufacturing. Desires position with production department of smaller Ontario industry. Good references. Interviews anywhere in central Ontario. Apply to Box No. 1270-W.

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

CIVIL ENGINEER, JR.E.I.C., JR.AM.SOC.C.E., Stud. Inst. C.E. Age 25, Scottish. B.Sc. Edinburgh '30. Three and a half years designing, estimating and draughting bridge and structural work; steel and concrete. Six months asst. supervising engineer on bridge construction. Passed final examination for A.M.Inst.C.E. Available immediately. Apply to Box No. 1295-W.

For Sale

Rolling sphere planimeter, Eugene Dietzgen Co., No. 1810. Adjustable tracer arm, max. 19¼". Any reasonable offer considered. Apply to Box No. S-27.

THE

ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public"

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Recent Developments in Sound Pictures

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Presented before the Montreal Branch of The Engineering Institute of Canada, March 7th, 1935.

SUMMARY.—After discussing available methods of recording sound and the basic principles of sound reproduction, the paper describes the greatly improved recording units now in use and the reproducing equipment by means of which a sound range of from 50 to 8,000 cycles can be accurately reproduced as compared with the 100 to 5,000 cycle range formerly possible.

Sound pictures are not of recent origin. Forty years ago experimenters were endeavouring to combine Edison's, and later Berliner's, phonograph with the motion picture camera and projector. Their problem was, however, one which was not capable of solution in a commercially practicable form, because the tools they had at hand placed fundamental limitations on their methods. In the first place, the only power available to press or engrave the disc or cylinder which was to serve as the storing medium was that derived from the lips or instruments of the performers. This meant that all sounds had to be emitted within a small area at the mouth of a collecting horn which terminated at the diaphragm to which was attached the recording stylus. Secondly, due to the necessity for placing the reproducing machine behind the screen in order to preserve the illusion that the sound originates from the image, the problem of synchronizing sound and picture was very difficult, and was solved only by a cumbersome arrangement of belts and shafting extending from the projection room to the stage. The third obstacle which made sound pictures impracticable was that the reproduced energy was limited to that which could be obtained directly from the record.

Thus for some years the development of sound pictures was retarded, just as was that of the long distance telephone, the radio and the phonograph. The invention and development of the vacuum tube gave an impetus to all these projects, by making available power to operate their devices. Present day sound picture technique did not descend from the attempts of the early inventors to make motion pictures talk; it came down through other arts, notably the allied sciences of radio, telephony, and the phonograph, and owes almost nothing to the first experiments in talking pictures. It was not until the advent of the vacuum-tube amplifier that sound pictures in the modern sense became feasible. The use of a microphone-amplifier-electromagnetic recorder system gave the performers the necessary freedom for dramatic effect. The electric reproducer-amplifier-loudspeaker combination in the theatre provided the necessary acoustic energy and simplified the synchronizing problem; and in 1926 the modern sound picture systems were placed on a commercial basis.

General Principles of Recording

In 1926 two general methods of sound recording for sound pictures were introduced in a commercial form:—

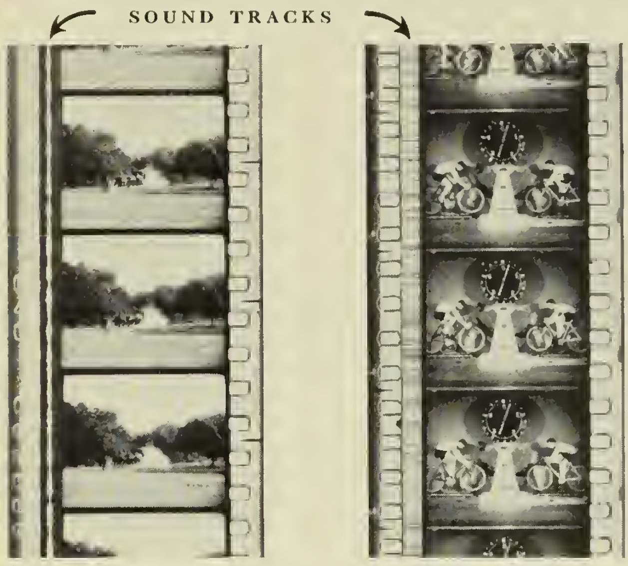
(*a*) The record could be made by a mechanical engraving process on wax, just as the familiar phonograph record is made. As far as sound pictures are concerned, disc recording is now a thing of the past, although it has recently been revived in a secondary function which will be described later.

(*b*) The record could be obtained photographically on film. This system is now used universally. Originally theatres were equipped for both disc and film reproduction, but now only film synchronous reproducers are in general use.

Wax Recording

Wax recording is done by engraving the surface of a wax disc with a cutting stylus attached to a vibrating armature. The armature is rocked between the poles of a magnet by the voice currents from the recording microphone, much amplified. The recording may be either lateral or vertical, that is, the movement of the stylus may be parallel to the surface of the wax disc, in which case the record appears as a wavy line of constant depth; or the stylus may move vertically to the surface of the wax. In this case, a straight cut of varying depth is obtained. Lateral recording is generally used for phonograph records, and was widely used in the early days of sound pictures. Vertical recording has, however, inherent advantages over lateral recording and will probably assume considerable importance as an intermediate process in film recording.

The discs are either of heavy wax or are made by flowing a thin surface of wax onto a heavy metal plate. The surface of the disc is then made conducting by brushing on a thin coat of finely powdered conducting material such as graphite, or in a more recent process by "cathode sputtering" of gold onto the wax surface. "Cathode sputtering" is a process of evaporating gold in a vacuum by the application of a high potential, and results in the deposition of an extremely thin, smooth, and uniform layer of gold on the wax surface. A heavy layer of copper is deposited electrically over this conducting film, and the wax is stripped off. This copper reverse impression is the "master." A separating fluid is applied to its surface, which is then given a heavy copper plating, which, separated from the master, gives a surface identical with the original wax. From this mould "sub-masters" or "stampers" are made again by electrolytic deposition of copper. A flash-



Variable Area Variable Density

Fig. 1—Sound Picture Records.

ing of chromium on these "stampers" makes them durable enough to stamp out the records actually used for reproduction from a thermo-plastic compound. Lateral-cut records have generally been made of a shellac-base compound. Vertical-cut records are now pressed in cellulose-acetate or similar materials.

Film Recording

In film recording systems the sound record is obtained photographically as a narrow strip along the edge of the same track that carries the picture. There are two main forms which this record may take:—

(*a*) It may be of uniform area but of varying opacity, the opacity being a definite function of the amplitude of the sound recorded. This is the "variable density" film recording system.

(*b*) It may be of uniform opacity with a variation in area corresponding to the variations in the sound it represents. This is the "variable area" recording system.

Variable area and variable density records are shown in Fig. 1, combined with the film carrying the picture. Other arrangements are conceivable by which a reproducible sound record may be obtained photographically, but these two are the only ones in use commercially.

The variable density sound record is made with a recording lamp of constant brilliancy, focussed on a light-valve, the opening of which in turn is focussed on the sound track of the film. This arrangement is shown in Fig. 3. The motion of the film is in a line perpendicular to the opening of the valve. The light valve is simply an electromagnetic shutter which is operated by the sound currents generated by the microphone. The present standard in recording practice is to use an average light valve opening of one mil,* focussed on the film half size. This gives an indication of the minuteness of the apparatus with which film recording is accomplished.

*One mil = .001 inch.

As is shown in Fig. 2, the light valve consists of an edgewise loop of duralumin tape with the inner edges of the two ribbons forming a slit .256 inch long and having a normal width of .001 inch. When an alternating current, such as the amplified current from a microphone, is passed through the ribbons, which are connected in series to form a continuous circuit, the two ribbons under the action of the magnetic field induced by the permanent magnet pole-pieces oscillate about their mean positions. In the two sides of the loop the ribbons move in opposite directions; that is, on one half of a cycle they move together and on the other half they move apart. Since the average opening of the valve, obtained when no current is being passed through it, is .001 inch, each ribbon has a maximum allowable displacement of .0005 inch; the total opening of the valve varies from 2 mils to complete closure, when an alternating current of maximum allowable amplitude is passed through it. This variation in the valve opening causes a corresponding variation in the width of the beam of light projected through it, and in the exposure of the film.

The valve forms a simple resonant system and the tension of the ribbon is adjusted so that the resonance lies just at the upper end of the frequency band it is desired to transmit. At frequencies below this fundamental resonance the ribbons have substantially the same displacement for equal currents.

In the variable area type of film recording, the record is made also with a lamp of constant brilliancy. The sound track is made by moving the light beam lengthwise across a slot interposed between it and the film. The film

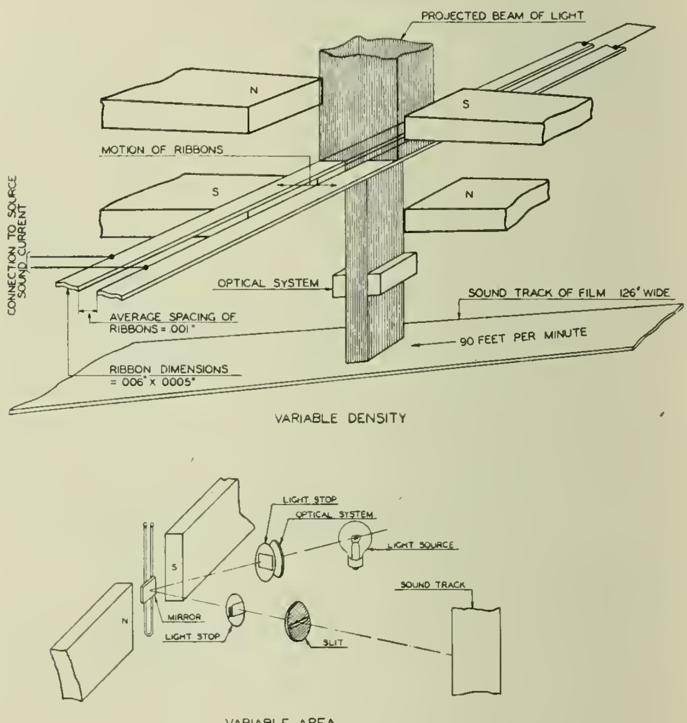


Fig. 2—Film Recorders.

moves at right angles to the direction of motion of the light. The recorder, or vibrator as it is called, consists of a tiny mirror cemented across a stretched loop of wire. The vibrator is placed between the poles of a magnet so that the wires are across the plane of the field. The light from the lamp is focussed through a square light stop onto the mirror of the recorder and is reflected through a cylindrical lens and a slit onto the sound track of the film. The edge of the light stop is focussed on the centre of the sound track which, therefore, under silent conditions is half exposed and half non-exposed. Sound currents through the vibrator cause it to rotate about a vertical axis. This oscillation causes the edge of the light which falls on the sound track to shift back and forth, thus producing a varying width of exposure on the sound track. Figure 2 shows a skeleton view of a variable area recording system. It should be noted that the variable area record shown in Fig. 1 consists of a double trace and is obtained by using a double recorder.

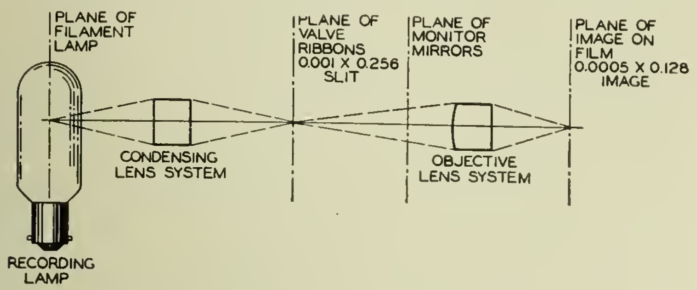


Fig. 3—Recorder Optical System.

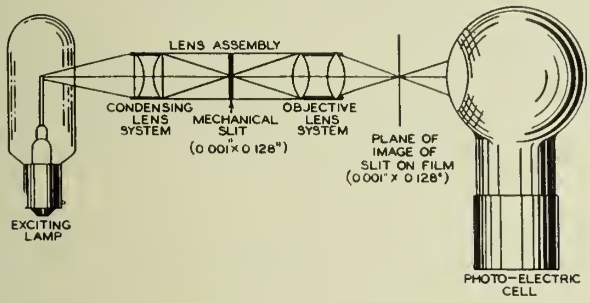


Fig. 4—Reproducer Optical System.

A third method of film recording, used until recently, has now been abandoned. In this system, a variable density record is produced, by means of a varying light source, through a slit of fixed area. A gaseous discharge lamp which varies its illumination in accordance with the amplified voice currents is used. The results of this method were not satisfactory when compared to those produced by the technique developed in the use of the other systems, and this method has now fallen into disuse.

General Principles of Reproduction

There are three essential elements in a reproducing system:—

(*a*) A reproducer to work from the film or disc record.
(*b*) An amplifier.
(*c*) The sound projectors.

An electromagnetic reproducer is used for translating the mechanical motion derived from the disc record into electric currents. These reproducers assume various forms, but all are of the general design in which an armature within a small coil vibrates as a needle attached to it follows the grooves in the record. The armature forms part of a magnetic circuit through which passes the flux from a permanent magnet. Variations in this flux cause a corresponding electric current in the coil. This is amplified, and projected through the loudspeakers as sound.

The reproducer for the film record uses as its essential device a photoelectric cell. Under the action of light the cathode of the photoelectric cell generates electrons which will carry a current across between the cathode and anode. Variations in this current reproduce faithfully variations in the light. The cell does not differentiate between a light pattern of constant intensity and varying area, and a light pattern of constant area and variable intensity. The reproducing arrangement is shown in Fig. 4. The light from the filament of the high-intensity exciting lamp is focussed on the film as a beam 1 mil wide. After passing through the sound track it falls on the light-sensitive surface of a photoelectric cell. It will be noticed as a fortunate circumstance that this system reproduces equally well variable-area or variable-density records.

Requirements for Reproducing Sound

A system for recording and reproducing speech, music and noise satisfactorily must perform within well-understood and clearly defined limits. Thanks to researches which have been carried on for many years, to-day we have a fairly complete picture of the types of distortion, discussed in purely physical terms, that are introduced in recording, transmission and reproduction. What is equally important, we know just how much distortion of each type is tolerable in various kinds of systems, we know what the performance of a system must be for distortionless transmission, i.e. transmission in which the distortion is not perceptible, and from a knowledge of the physical characteristics of our pieces of apparatus we can form an accurate idea of how the reproduced sound will compare with the original. We now have the dictionary that will translate terms describing sound like dull and brilliant, shrill and heavy, harsh, smooth, full, thin, and a host of others, into definite technical statements.

In the electrical transmission of sound we are mainly concerned with three types of distortion. The first is that caused by the fact that the reproducing system transmits different frequencies unequally, and is called *frequency distortion.* In the degree in which the three types are usually heard, this is the most noticeable. The second form of distortion is called *harmonic distortion* and is due to the presence in the reproduced sound of frequencies which were not present in the original. This is the form of distortion present when a vacuum tube circuit is overloaded. The spurious frequencies generated are integral multiples or *harmonics* of frequencies in the original sound; hence the term harmonic distortion. The third type of distortion is *phase distortion.* This occurs when the time taken for the transmission of sounds through the system varies with the frequency, that is, different frequencies have different times of transmission. Phase distortion takes place when the phase shift of each component is not proportional to its frequency, and is ordinarily not present in recognizable amounts.

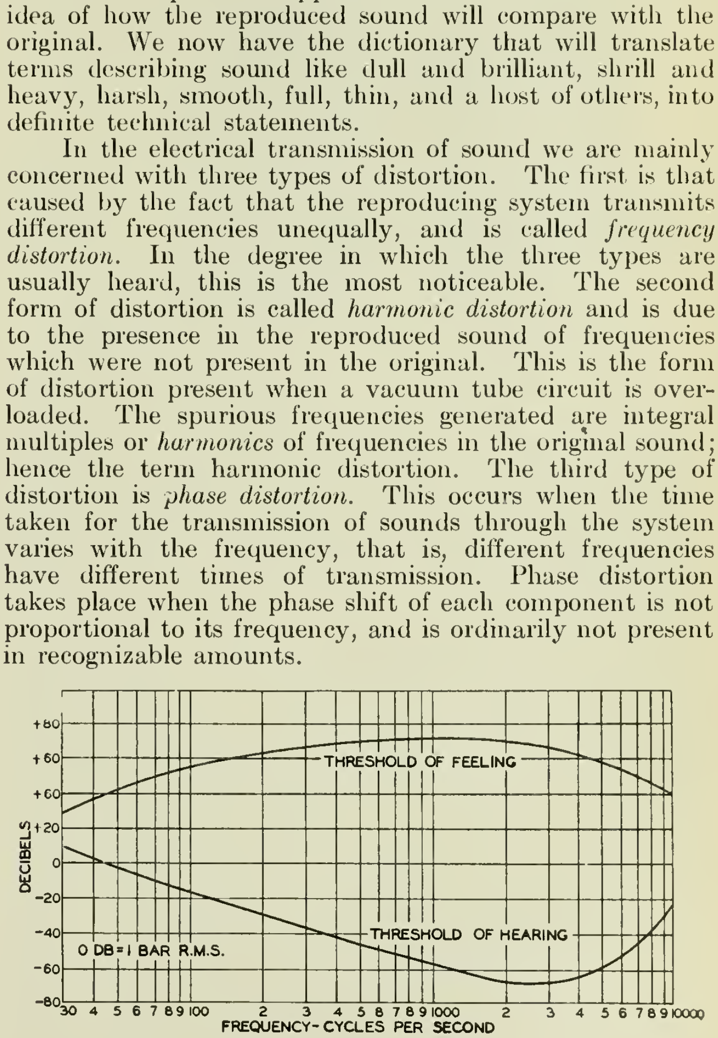


Fig. 5—Audibility Curves.

Figure 5 shows the audibility curve for the human ear. All acoustic vibrations of such an intensity and frequency that they fall within the area enclosed by the two curves, are audible, and are perceived as sounds. Acoustic disturbances of high intensity lying above the upper curve give rise to the sensation of feeling. This effect is commonly experienced when the bass pipes of a large pipe organ are played. Vibrations which lie below the lower curve are not perceived at all. That is to say, there is a definite intensity limit for the human ear, below which disturbances are inaudible and above which they are audible. This limit is called the "threshold of audibility" and its exact value for any person depends on the average noise level; for the city dweller it is much higher than for one who lives in the country. The horizontal frequency scale of this figure is logarithmic; the vertical intensity scale is plotted in decibels. The zero line represents an

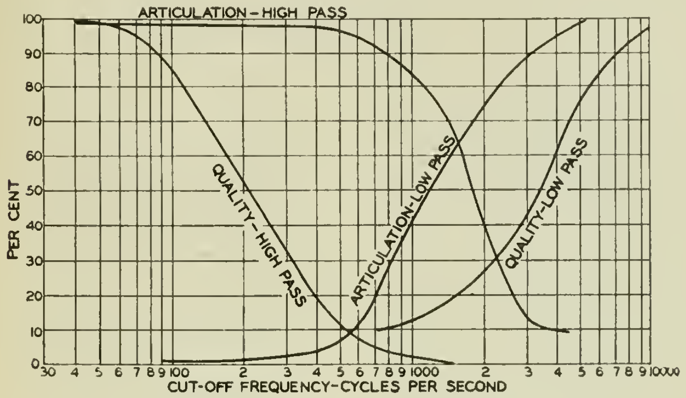


Fig. 6—Quality and Articulation Curves.

r.m.s. sound pressure of one bar (one dyne per square centimeter). The decibel is a logarithmic unit in general use to-day for expressing power ratios, and the number of decibels expressing the ratio of two powers is obtainable thus:—

$$\text{Decibels (abbr. "db.")} = 10 \log_{10} \frac{\text{Referred power}}{\text{Reference power}}$$

The 20 db. intervals on Fig. 5 each represent, therefore, power ratios of 100 : 1. It is interesting to note that at the widest part of this area the human ear can distinguish about 1,300 pure tones perceptibly different in pitch. At 1,000 cycles about 270 perceptible loudness increments exist, and it is estimated that the ear can detect a total of about 300,000 pure tones differing in pitch and loudness. This gives some measure of the magnitude of the problem which confronts us when we propose a distortionless sound reproduction system.

Figure 5 indicates a type of distortion which is not connected with the reproducing system itself, but is a result of the characteristics of the ear. This distortion results when sound is reproduced at a different volume than that existing at the point at which the original sound was picked up. In other words, if two sounds are projected, identical in waveform but of a different amplitude, the ear hears them as different not only in loudness, but also in composition. This is readily seen by reference to the figure. Suppose the music of an orchestra was picked up by a microphone at an average intensity of −10 db. and reproduced through a loudspeaker at an intensity of −30 db. The effect is seen to be that all frequencies between 75 cycles and 200 cycles in the original sound have been largely eliminated. Exclusive of any electrical and acoustic requirements on the transmitting system itself, then, distortionless transmission requires that the sound be reproduced at the volume of the original. In general, if sounds are reproduced at less than natural volume, the frequency range will be narrowed.

The two "quality" curves of Fig. 6 show the effect of the upper and lower cut-off frequencies of a transmission system on the quality of orchestral music. These curves may be considered to be approximately true also for quality of speech. It is seen that a noticeable deterioration in quality occurs when the lower cut-off point is higher than about 70 cycles. The upper point at which quality deterioration is evident is very high, about 16,000 cycles for orchestra music and 10,000 cycles for speech.

The audibility curves of Fig. 5 show that the ear is capable of hearing sounds which differ in amplitude by about 140 db. For distortionless reproduction, however, it is not necessary to reproduce this range, since the maximum volume variation of the human voice is only about 40 db., and of a symphony orchestra, 70 db. Apparently the requirement for a distortionless system is not greater than 70 db. What we mean when we say that a transmission system will reproduce a volume range of 70 db. is that when the sound is reproduced at its original level, the system will not overload on the maximum peaks, and the sound at the lower edge of the 70 db. band will not be masked or interfered with by extraneous noise; this implies that at normal volume, noises introduced in the system must be near or below the threshold of audibility.

How well are these requirements for distortionless transmission met in sound picture systems? The over-all frequency response from the sound pressure in the recording studio to the intensity at the listener's ear in a theatre is substantially uniform from 50 to about 8,000 cycles, the harmonic distortion is nearly negligible when the equipment is properly adjusted and the photographic processes are carefully controlled; the noise level is near or below the threshold of audibility, and the intensity at the listener's ear is of the same order as it would be were he actually viewing the scene being projected. The normal volume range of 40 to 60 db. for ordinary action has been somewhat compressed, however.

Description of Reproducing System

In a theatre there are two projection machines, and a continuous show is obtained by running one machine

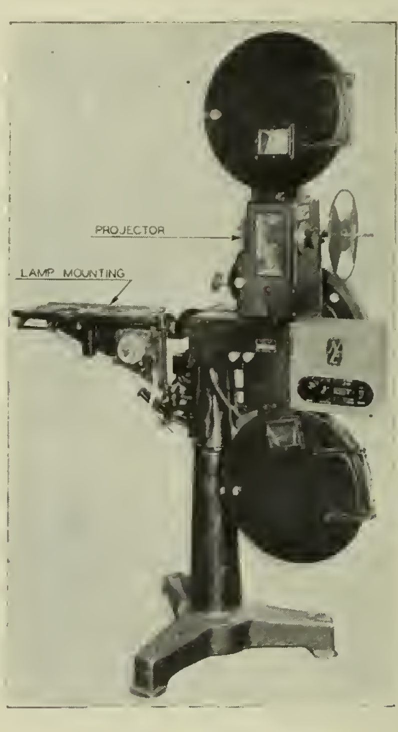


Fig. 7—Projection Machine.

while film is being threaded into the other. The operator then watches and listens for a cue which is indicated on a cue-sheet sent out with each set of prints. This cue generally takes the form of punch-marks in the upper right-hand corner of several successive pictures. When he sees this, he starts his second machine, and when it has come up to speed, switches over picture and sound simultaneously. The uniformity of projectors and the acuteness and dexterity of operators are such that this change-over is generally accomplished without being in any way perceptible to the audience. In theatres, where the fire hazard is severe, the projection machines are always in fireproof projection rooms.

In Fig. 7 is shown a projection machine, which includes the mechanism for projecting the picture, and also for picking up the sound track from the film. The picture projector includes the lamp, which is usually an arc lamp, the mechanism for imparting to the film the intermittent motion required for motion pictures, a shutter and the necessary optical system.

The film is on a reel in the upper magazine. It is drawn down through the picture projector, then through the sound reproducer mechanism below the projector, and finally winds up on a reel in the lower magazine. There is a distance of about 14½ inches between the points where the picture and sound are taken off the film; this is compensated for by displacing the picture and the sound-track 14½ inches when making the positive prints.

The sound reproducer shown in Fig. 8 is a standard design used generally throughout the world. The driving motor is a squirrel-cage induction motor with a split-phase starting winding, mounted in a rubber cushioned frame to minimize vibration. It drives a large flywheel through two parallel fabric belts. This type of drive provides a very efficient filtering action, resulting in uniform speed of the film past the photoelectric cell, and consequently, freedom from objectionable flutter disturbances. The *sound sprocket* on the same shaft as the flywheel pulls the film past the photocell, and a floating gear on the same shaft drives the projector through a gear and pinion above it, and a second film sprocket below it. The lower or *take up* reel is driven through a friction clutch by a belt, and this second or *hold back* sprocket prevents the film being pulled tight on the sound sprocket as the diameter of the reel of film in the take-up magazine increases. Since the smallest variation from uniformity in the velocity of the sound track past the photocell will appear as noise in the loudspeakers it is important that gear ripple and flutter due to the *intermittent* mechanism should be filtered out of the system before they reach the sound sprocket.

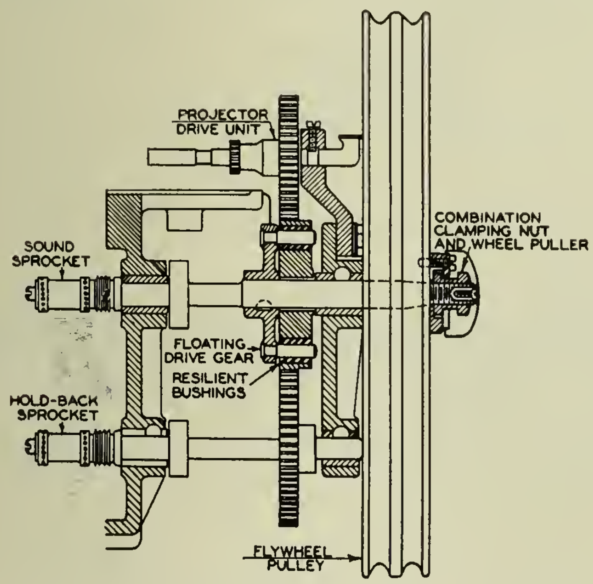


Fig. 8—Cross Section of Film Reproducer Mechanism.

The photocell, which performs the function of converting the light variations into current variations, is contained in the unit on the forward end of the projection machine. The photocell on each machine is transformer-coupled to the control and switching circuit. Since the alternating current output of the photocell is only a few millionths of an ampere, extreme care has been taken in the design of this part of the equipment to ensure against extraneous electrical disturbances. From these photocell coupling units which transform the high impedance of the photocells to a low value, suitable for transmission over ordinary paired wire to the rack-mounted equipment, the sound currents enter the main amplifier.

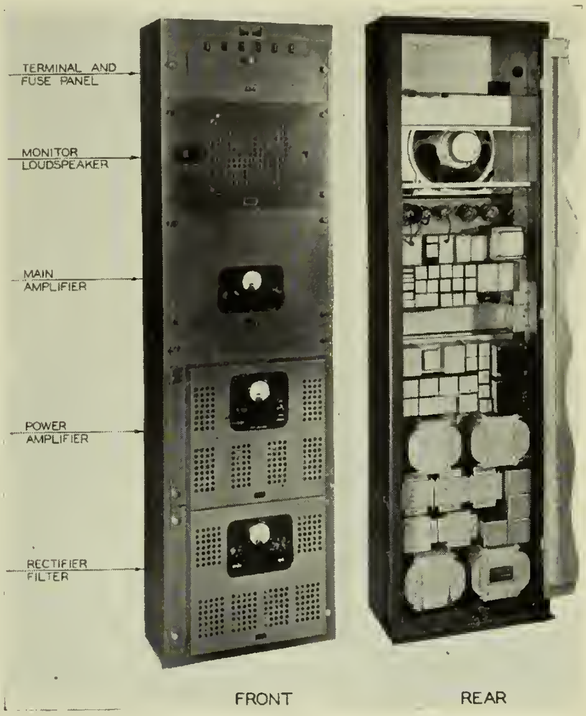


Fig. 9—Theatre Amplifier Equipment.

This is one of the five units mounted together to form an integral assembly, shown in Fig. 9, which is located in the projection room along with the projection machines. It is an a.c. operated four-stage amplifier with characteristics which represent about the ultimate reached to-day in commercial amplifier design. In all but the very large theatres the output of this amplifier operates the loudspeakers. In very large theatres its output is used to drive the power amplifier below it. It has a maximum gain of about 110 db. (equal to a power amplification of 10^{11}) and a maximum non-distorted single-frequency output power of about 15 watts. All the tubes have a.c. heated cathodes, and the plate supply is obtained from a full wave rectifier and filter forming part of the amplifier itself. Due to the extraordinary efficiency of the output tubes, the plate power supply is relatively small.

At the bottom of the rack is the 24-volt rectifier-filter unit that supplies direct current to the exciting lamps, the signal lamps and the speaker fields; this unit uses two half-wave tungar bulbs in a conventional arrangement. All the a.c. and d.c. power circuits are fused here. The rack is completely assembled and wired in the factory, and the installation work consists of connecting a factory-made cable between the terminal panel and the machines, and the power leads and circuits to the loudspeakers on the stage. Below the terminal panel is mounted a small loudspeaker, which enables the operator to follow the action.

The mechanical arrangement of the apparatus is novel, and has resulted in extreme accessibility of the component parts and wiring, compactness, lowered costs, and improved appearance. The construction is shown in Fig. 10. The apparatus of each unit is mounted on a bent and welded pan-shaped chassis which is mounted on the rack by flanges at the ends. The rack itself is in the form of a completely enclosed cabinet. The controls and meters of each unit are mounted on hinged panels. The wiring is cabled and flexible conductors are used so that the cable bends with the hinge. Each chassis is fastened to the rack with flat-head machine screws; the front of each panel is covered by a sheet metal mat which fastens to the rack with thumb screws and has a square cut-out to expose the controls.

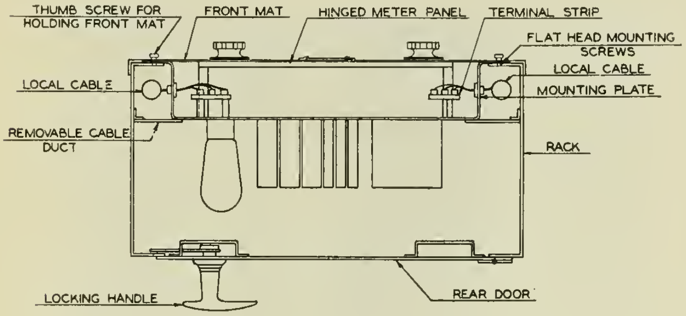


Fig. 10—Cross Section Through Typical Depressed Panel Type Unit Mounted on Cabinet Type Rack.

The wiring and terminal strip for each unit are contained in the face of the chassis, under the mat. The cabling between units comes through bushings in the edge of the chassis, and is concealed along the length of the rack by a removable cable duct.

The mechanical arrangement of the photocell coupling units, shown in Fig. 7, is somewhat different. They are composed of stud-mounted apparatus mounted on the top of a horizontal chassis, with the controls mounted on the front edge. The front cover-plate has an oblong cut-out to expose the controls. The unit slides into a bent and welded sheet-steel case; to examine the wiring it is only necessary to remove the front cover, slide the unit forward, and then let it drop forward about a hinge on the front lower edge.

The photoelectric cell consists of a caesium-oxygen coated silver cathode and an anode in an evacuated bulb. Although the current from it under the usual illumination used is measured in microamperes, even so this is ten times that obtained from the photocells originally used. This increased current, together with the lower internal impedance of the cell have made possible the great simplification in the new equipment due to the use of a transformer coupling circuit between the photocells and the main amplifier, in place of the preliminary amplifiers immediately associated with the photocells, necessary in the previous equipments.

It is only the extremely useful characteristics of the tube used in the first three stages of the amplifier which have made it possible to produce all a.c. operated equipment of this type. The limiting factors in a.c. operated amplifiers have previously been, first, the power noise introduced into the circuit from the alternating heating current of the cathode of the first tube and, second, the cathode hiss or emission noise generated in the first tube due to the statistical variation in the emission of electrons from the cathode. In this tube these factors have been reduced by about 20 db. over previous designs, so that it is now possible to build commercially this a.c. operated amplifier with a gain of over 110 db., in which thermal noise, which is a natural limiting noise level, masks other noise present.

Two tubes are used in push-pull in the output stage of the amplifier in a straight class "A" arrangement, and a plate circuit efficiency of better than 40 per cent is realized. The ideal efficiency (i.e. ratio of maximum undistorted single frequency a.c. output to d.c. plate input power) of a class "A" amplifier is 50 per cent, and the figure 40 per cent represents an efficiency several times that of previous tubes and amplifiers.

When very high output power is required the power amplifier, shown in Fig. 9, using a pair of triodes in push-pull in a modified class "A" circuit, is used. A plate supply of 1,500 volts is obtained from a full wave bridge rectifier, using mercury vapour tubes, and the grid bias is obtained from a separate full wave rectifier circuit. This amplifier will deliver upwards of 100 watts of audio power with negligible distortion and is used for extremely large theatres and auditoriums.

The loudspeakers employed with the new theatre equipment are of three general types: first, large dynamic cone units similar in general arrangement to the conventional radio set loudspeaker, second, large exponential wooden or steel horns equipped with moving coil driving units and third, small high frequency units consisting of a coil driven diaphragm coupled to a small metal horn. The large horns are of the conventional type that have been in use for a number of years, in fact since the inception of sound pictures. The high frequency units are, however, a recent development; the cross-section of one of these units is shown in Fig. 11. This unit transmits with an efficiency of about 50 per cent the frequency range from 3,000 to 13,000 cycles and is always used in conjunction with one or both of the other types of speakers. When the large dynamic speakers are used, they may be used alone or with either or both the other units. When used alone, they transmit the frequency range from the low end of the frequency spectrum to about 8,000 cycles at the upper end and a group of them are mounted together on a large baffle. In equipments where it is desired to get extremely good frequency response, the small high frequency units are used in addition, and an electrical dividing network is connected to split the amplifier output, transmitting frequencies up to 3,000 cycles to the large dynamic cones and frequencies above 3,000 to the high frequency units.

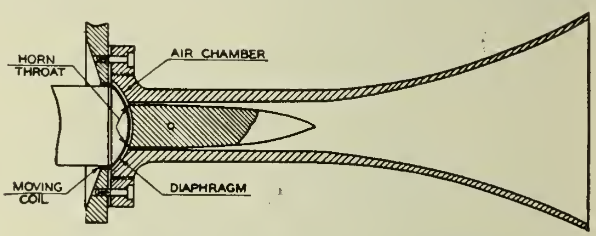


Fig. 11—Cross Section of High Frequency Unit.

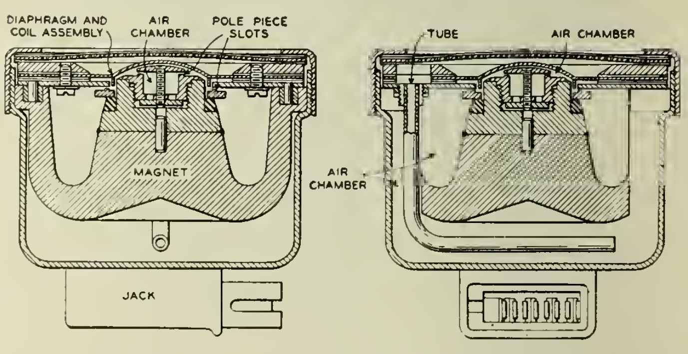


Fig. 12—Cross Section of Microphone.

In large auditoriums and wherever it is difficult to get good sound distribution, the large horn type projectors are used in addition, transmitting the middle frequency range, for which they project a somewhat directional beam of sound.

The new tubes, the new photocells and the new loudspeakers have permitted a considerable improvement to be made in the performance of the original theatre equipment placed on the market in 1926. This improved reproduction is perceptible to the audience in three ways:—First, the transmitted frequency range is considerably improved; in place of the former 100 to 5,000 cycle range it is now possible to reproduce accurately a 50 to 8,000 cycle range. Second, the volume range has been considerably improved. Sound pictures up till a year or two ago rarely were able to effect a volume range greater than about 30 db.; this range has been increased by some 10 or 15 db. due to lower noise levels which previously limited the lower end, and higher power amplifiers, which have increased the range upward. Third, the background noise caused by the film and the reproducing system has been markedly reduced.

Description of New Recording Units

A great improvement in recording has been effected in the last few years. This has been due both to the development of new apparatus and to experience gained in the technique of film recording. The dynamic microphone, of which a cross-section is shown in Fig. 12, has greatly improved the pick-up technique in the sound studios. It consists of a formed duralumin diaphragm to which is cemented a voice coil moving in the slot of a permanent cobalt-steel magnet. This microphone has an extremely uniform response characteristic, being substantially flat from 30 cycles at the low end to over 10,000 cycles at the high end. It is small, compact, sturdy, and is not subject to barometric or humidity conditions and does not require, like the condenser microphone, a closely associated amplifier, or like the carbon microphone, a direct current supply. Recording amplifiers have been equalized to obtain a frequency response characteristic uniform to 10,000 cycles.

The technique of light valve recording has been the subject of continuous development work. One improvement which has been generally put into use is that known as noiseless recording. A large part of the film noise or film hiss previously obtained in film recording was due to the fact that during silent periods when no sound was being transmitted, the light valve was open to its normal operating point and the film was partially exposed at a constant density. Due to the grain of the photographic deposit on the positive, this partial exposure gave a steady scratching or hissing noise when reproduced. This hiss is directly proportional to the exposure of the negative. In noiseless recording the light valve is biased partly shut by direct current, thus reducing the average exposure during silent periods. When sound is being transmitted, the d.c. bias is reduced automatically, permitting the average spacing of the valve to increase sufficiently to pass the signal without clashing.

Other developments which are under way by many workers in the field look towards more satisfactory control of the photographic processes. Figure 13 shows the characteristics of photographic emulsions. On this curve the relative density of the photographic deposit is plotted on the ordinate scale and the logarithms of the exposures giving these densities are plotted as the abscissae. Since the variable density system of film recording depends for its success on a linear relation between the amplitude of the sound to be recorded and the intensity of the light falling on the reproducing system photocell, this linear relation must be preserved through the intervening photographic processes. The least number of processes through which the record must pass is four—that is, exposure of the negative, development of the negative, printing of the positive, and development of the positive, and the sum total of these processes must yield a linear relation. This means, then, that the film must be worked along the straight line portion of the overall negative-exposure positive-density curve. It is evident that the length of the straight line portion of this curve limits the volume range which can be recorded. A further requirement on the photographic processes and one which is equally important is that the contrast in the record must be preserved at approximately the correct value, since to reduce the contrast would result in a compression of the volume range and to increase it would result in an extension of the volume range. If the original exposure of the film made full use of the volume range indicated by the exposure-density curve, then this increase in contrast obtained in the developing and printing processes would, of course, result in serious

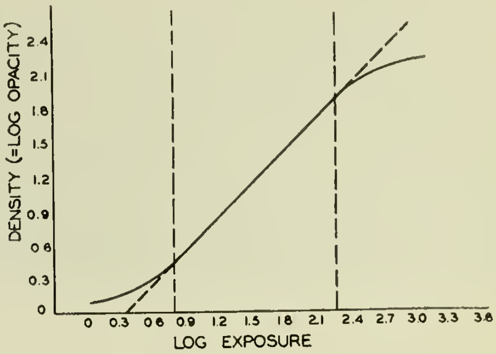


Fig. 13—Exposure-Density Curve for Typical Emulsion.

non-linearity. It can readily be shown that another way of stating the requirement that the contrast must be maintained is to say that the slope of the exposure-density curve obtained by plotting the density of the final print against the exposure of the negative must be unity. Since the first days of sound pictures a great deal of development and research work has gone forward to determine the exact relations involved in order to produce photographic emulsions for which the straight line portion of the exposure density curve is of adequate length and this work is producing results in greatly improved film and film processing.

Due partly to the difficult technique and the sometimes uncertain results obtained in the photographic processes, but mainly due to the fact that vertical disc recording inherently has advantages over film processes so far as frequency range, volume range and noise level are concerned, a new technique has been developed recently by which all intermediate processes in sound film production are carried out on vertical cut disc records. The vertical cut disc has a frequency range extending to 10,000 cycles and a noise level near the threshold of audibility. In addition, the non-linear distortion introduced is negligible. In the production of sound pictures, there are frequently a number of re-recordings required in the editing and piecing together of the film so that an improvement in the re-recording process will result in a considerable overall improvement in the quality of the final prints.

What new developments may we expect in sound pictures in the future? We now have high quality sound, and coloured pictures, so that our representation is reasonably close to good illusion. There are two things which we may now expect; first, production of pictures in relief, that is, stereoscopic projection, and second, production of sound in relief—stereosonic projection. Both these effects have been accomplished on a small scale basis and now await only commercial development. Both will add considerably to the effect of reality in the motion picture theatre and will add immensely to the enjoyment of motion pictures by the many millions who rely on that theatre as their main source of entertainment.

DISCUSSION

W. M. Gardner, A.M.E.I.C.[1]

How does the frequency characteristic of the system described, of which we have heard a demonstration, compare with the ranges transmitted by the telephone and the phonograph?

[1]Supt. of Construction and Maintenance, Montreal Tramways Company, Montreal.

S. T. Fisher, Jr.E.I.C.[2]

In these films you have heard, a frequency range of about 70 to 7,000 cycles was transmitted with substantial uniformity. In a first-rate theatre installation, where equipment of this type is used and where care has been taken to adjust the acoustic conditions and to obtain proper distribution of the whole frequency spectrum, a characteristic flat between 50 and 8,000 cycles is obtained. As you will note from the curves of Fig. 6, transmission down to 70 cycles results in reproduction which is almost ideal at the lower end; at the upper end of the audible range cut-off at 8,000 cycles results in only a small deterioration in quality. This wide frequency range is necessary to give naturalness to speech and to preserve adequately the dramatic effects of music. In the mechanical phonograph a frequency range from about 150 cycles to 4,000 cycles is attained; the electric phonograph does somewhat better, reproducing frequencies from about 70 to about 5,000 cycles. A direct comparison would show plainly that this is much poorer than the reproduction you have heard to-night.

On commercial telephone circuits a very much narrower band of frequencies is transmitted. It is seen from the curves of Fig. 5 showing how articulation (or intelligibility) varies with the transmitted frequency range that cut-offs of 300 cycles and 4,000 cycles give almost ideal articulation, even though the quality of transmission is very poor.

Where telephone circuits are used for transmission of broadcast programme material a transmission from 50 to 8,000 cycles is frequently provided.

J. L. Clarke, M.E.I.C.[3]

It has been my experience that when small photographs are enlarged, the photographic grain becomes very noticeable. Are not the effects of this grain serious in sound-on-film recording?

S. T. Fisher, Jr.E.I.C.

As Mr. Clark has pointed out, in sound-on-film recording, where the dimensions of the recording and reproducing light beams and of the variations in the density or area of the record are extremely small, the grain of the photographic deposit presents a problem. You will remember that in the days of silent pictures the grain was very noticeable on the screen, and in the first sound-on-film recording this was one of the major problems. The noise due to this grain has been overcome largely by the development of new emulsions and new processing technique, which have resulted in a much more homogeneous deposit on the positive prints. Another factor, of course, has been the introduction of the so-called "noiseless" recording, which reduces the grain noise by reducing the average exposure of the negative.

E. S. Kelsey, A.M.E.I.C.[4]

The noise introduced by the grain of the deposit on the film is due to variation in the grain, that is, it is a statistical effect, and is proportional, not to the grain itself, but to the variation in the grain.

F. S. Fisher, Jr.E.I.C.[5]

What proportion of the theatre reproducing equipment demonstrated is manufactured in Canada?

S. T. Fisher, Jr.E.I.C.

About 95 per cent of the total cost of the equipment is represented by material and parts purchased in Canada, and Canadian labour.

[2]Engineer, Northern Electric Co. Ltd., Montreal.

[3]Transmission and Foreign Wire Relations Engineer, Bell Telephone Company of Canada, Montreal.

[4]Engineer, Northern Electric Co. Ltd., Montreal.

[5]Engineer, Northern Electric Co. Ltd., Montreal.

A Concrete Bowstring Arch Bridge

Across the Grand River at Bridgeport, Ontario

D. J. Emrey, A.M.E.I.C.,
Engineer, Kitchener Good Roads' Commission, Kitchener, Ont.

Bridgeport is one of the pioneer villages of the county of Waterloo, being situated on both the east and west sides of the Grand river, and equally distant from Kitchener and Waterloo. At one time Bridgeport gave promise of growing into one of the more prosperous and thriving villages of the county, but on the building of the Grand Trunk Railway through this section about 1852, the line passed through Kitchener some two miles distant from the village, and this had the effect of retarding its growth while the city of Kitchener continued to forge ahead.

The construction of a new bridge across the Grand river at Bridgeport had been contemplated for some time by the Kitchener Suburban Commission, but due to the depression the Commission did not think it wise to proceed. Last year the Federal and provincial governments suggested a scheme of work for the unemployed by which the Federal government was to pay one third, the provincial government one third, and the owner the remaining one third of the labour costs; that is, for projects approved by the combined governments. The Commission decided to take advantage of this scheme and made application for permission to construct the bridge, which offer was accepted.

The old bridge was located on a curve of the river and it was decided to rebuild in the same location. Figure 1 shows the old bridge and the river in flood.

The old bridge consisted of two main spans each 107 feet long and 16 feet wide, then came a section of highway about 117 feet long, located on an island and contained between two concrete retaining walls. This was followed by another bridge 96 feet long by 16 feet wide over a flood channel. Due to the height that the floods attained at times, it was decided that (*a*) a girder bridge was out of the question; (*b*) as it was an unemployment scheme for local labour it should be a concrete bridge; (*c*) due to (*a*) and (*b*) the only type of bridge to fit the location was a bowstring arch; (*d*) the island should be excavated to 2 feet above the approximate low water level; (*e*) the bridge should be designed to consist of five spans each of 82 feet 2 inches with a 24-foot roadway and a 5-foot 6-inch sidewalk on the upstream side.

The total length of the bridge is 457 feet 2 inches to the ends of the wing walls. The height of the floor is 19 feet above approximate low water level, and the foundations extend to a maximum of 15 feet below low water level into hardpan. Figure 2 shows the completed bridge. The lamp posts are of concrete and add a decided finishing touch to the structure.

Design

In figuring the stresses, class 20H loading in accordance with the general specifications for Highway Bridges, 1933, was used. The loading allows for:

(*a*) Maximum uniform live load of 100 pounds per square foot of roadway or (*b*) two lanes of 15-ton trucks with the trucks following each other at 30 feet apart, or

Fig. 1—Old Bridge across Grand River at Bridgeport, Ont.

one lane of 20-ton trucks following each other at 30 feet apart.

(*c*) A uniform live load of 100 pounds per square foot on the sidewalk, but only 25 pounds per square foot to be used with case (*a*) or (*b*) in figuring loads in arches. An impact factor of 30 per cent was added to the truck load stresses. Influence lines were used to ascertain the position of trucks for maximum stress in the arch ribs. Hard grade steel was used throughout with an allowable working stress of 20,000 pounds per square inch except for hangers and ties, where soft grade steel was used with a permissible stress of 16,000 pounds per square inch.

The piers and abutments were designed as straight gravity piers and abutments. A typical pier is illustrated in Fig. 3 and abutment No. 1 in Fig. 4.

A general elevation plan of the bridge is shown in Fig. 5.

The floor is a straight beam and slab design, with the concentrated load for a 20-ton truck with 80 per cent of the load on rear axle found by

$$P = \frac{\text{40 per cent of weight of truck}}{(2/3\ l) + t \text{ (not to exceed 6 feet)}}$$

l = clear span in feet

t = width of tire in feet − 1 inch per ton.

it will easily be seen that in this type of bridge the beams supporting the deck must be arranged transversely as shown in Fig. 6 which shows a cross section of the bridge.

There is an economical thickness of the slab which in turn governs the spacing of the beams. This thickness of slab is governed by the shearing stresses, in other words the slab has to be of a certain thickness in order that the shearing stresses shall not become serious. Referring to Fig. 6, it will be seen that the deck platform is on the same level as the tie beam. This is done purposely, and in conjunction with the vertical suspender at the end of each beam provides an inherent transverse stiffness at frequent intervals.

Design of Curved Rib

The curved rib members are considered as two-hinged arches, and are made of parabolic form. The rise of the curved rib is taken as at about one-sixth the length of the span.

The horizontal thrust $H = Pl/8f$ where P = load, l = span, f = rise.

The axis of the arch is a parabola of the second degree. Thus, the line of resistance for a uniform load over the entire span falls on the axis of the arch and causes no bending moments or shearing forces to be developed in any section of the arch. The bending moment at any point is $Ms = Mf - Hy$ where Mf is the bending moment in a freely supported beam, y = vertical distance of the centre of the section from the support, and H = horizontal thrust at the point. Calculations for several different arrange-

Fig. 2—New Bridge at Bridgeport.

ments of loading have to be made to ascertain the maximum positive and negative moments developed.

$$S \text{ max.} = \frac{H}{\cos\alpha\ Ae} \pm \frac{My}{Ie}$$

α = angle of tangent to rib axis with horizontal at section considered.

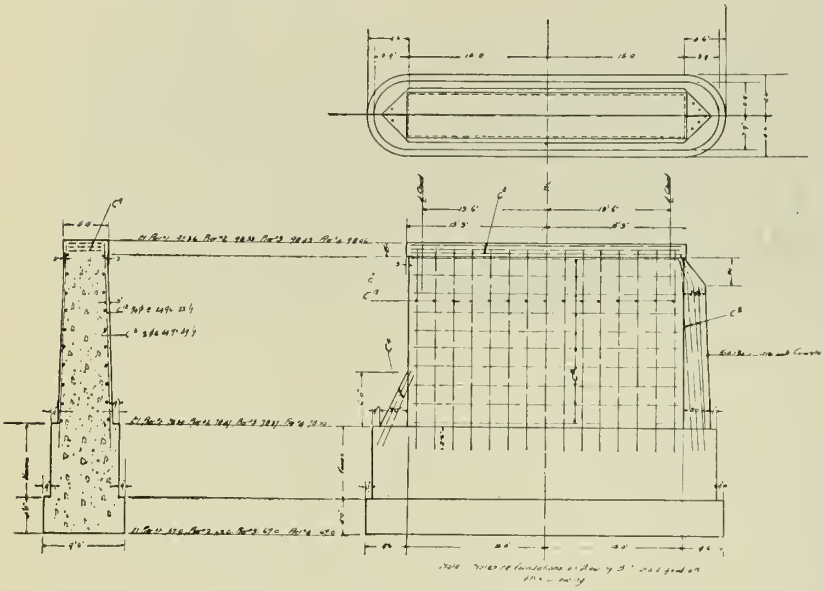


Fig. 3—Detail of Typical Pier.

Connection of Curved Ribs with Horizontal Ties

A point of vital importance and one requiring most careful attention when detailing the reinforcing and during construction, is the connections between the curved rib and tie.

The distribution of stress at these points is by no means uniform, and great care is required to design the junction of these members in such a way that the tension in the horizontal tie is gradually absorbed from the longitudinal reinforcement and transmitted to the curved rib, where it neutralizes the horizontal component of the normal compression force in this member.

Another point of interest is that of extending the bottom portion of the expansion plate under the fixed end of the arch. (See Fig. 7.)

Construction

Bids for the construction of the bridge were received from several contractors as follows, the Commission supplying the cement and reinforcing:—

	Total cost
Storm's Contracting Company Limited	$67,680.95
Windsor Construction Company Limited	67,838.52
Cameron and Phin	68,183.80
R. A. Blyth	69,306.60
Dunker Brothers	69,306.60
Bowman and Martin	72,318.50
Aiken, Innes and MacLachlan	79,084.00
W. Holdcroft and Co. Ltd	79,175.30
Ball Brothers	79,239.65
Ryan Contracting Company	79,200.84

and several others.

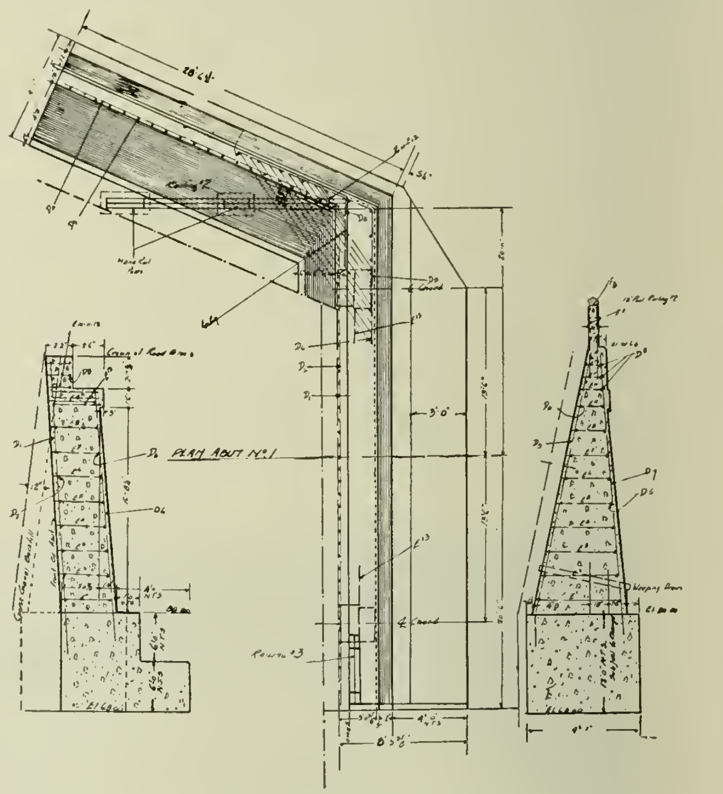
The contract was awarded to the Storm's Contracting Company of Toronto, and was carried out under Mr. Harry Weller as general superintendent. The work was done in a thorough workmanlike manner to completion, and if all contracts were carried out as satisfactorily the life of the inspector and resident engineer would be a happy one. The construction was started toward the end of April, 1934, and the work carried on with one shift except for the pouring of the floor and sidewalk, when two shifts were used.

As the water level at this time was about 3 feet above normal low water and the current was consequently rather fast, it was decided to begin at the easterly end so that by the time the work had progressed to the completion of the east abutment and two easterly piers, the water would be sufficiently low to warrant work on the west abutment and the two westerly piers which were in the river proper.

This programme was successful beyond expectation as contrary to the general belief there were no floods or high water of any kind during the entire summer. In fact the water was so low and the flow so small that a ford was constructed upstream from the bridge. This was used to divert traffic and also made both ends of the bridge accessible.

The existing steel spans were practically coincident with the new structure and all possible use was made of them; the spans being dismantled only as the progress of the new work required.

The excavation of the island was carried out by pick, shovel and teams. Excavation for the east abutment and the two easterly piers was done by the open cut method, using a Koehring crane and clam shell bucket. The material encountered was clay hardpan underlying a 12-foot layer of water-bearing gravel. Continuous pumping was necessary, which lowered the water table to such an extent that the neighbouring wells were put out of action temporarily.



a b c

Fig. 4—Detail of Abutment No. 1.
a Section through Abutment.
b Plan of Abutment.
c Section through Wing Wall

The hardpan was excavated with the use of air spades. Excavations were cut neat to line and concrete poured

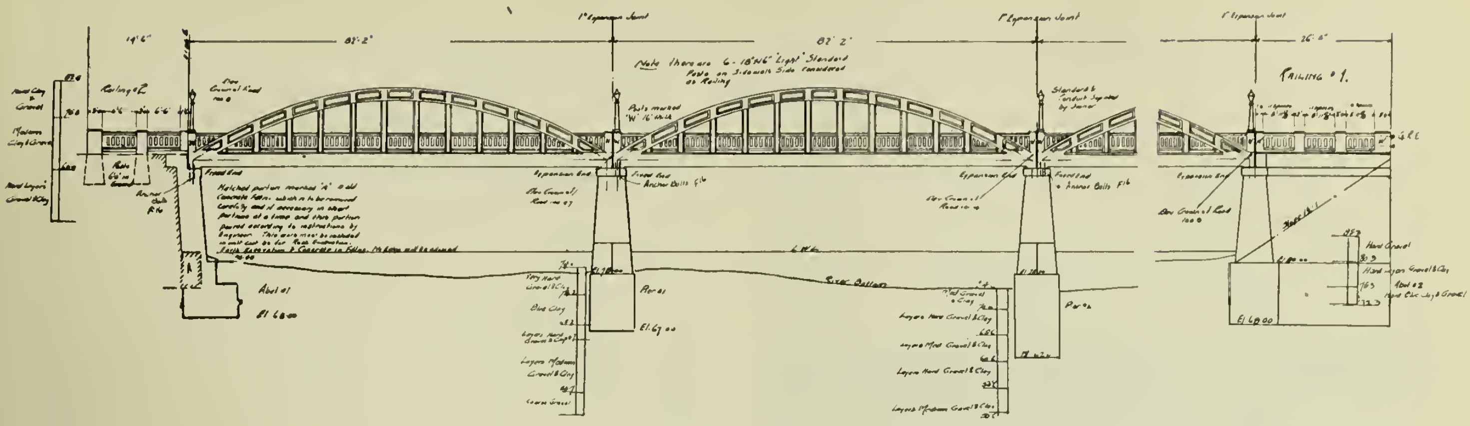


Fig. 5—General Elevation of Bridge.

without forms to 2 feet below the surface of the hardpan.

The excavation for the west abutment and the two westerly piers being in the river proper, had to be unwatered. This was accomplished without any trouble by throwing an earth dam from the island to the old pier which was about the centre of the river. This dried out half the river and besides allowing the excavation to be done in the dry, also allowed the placing of underpinning piles by hand. This was accomplished by sinking the butts of the piles down about 2 feet into the hardpan. The material encountered in this section was the same type of hardpan as on the east end with a layer of large boulders in the river bed. When work was finished in this part of the river, the wings of the dam were thrown back to the west shore and that section handled in the same manner. Figure 8 is a general view showing the old cofferdam from the island to the old pier and the cofferdam in use from the old pier to the west bank. The excavation for pier No. 1 is also shown with abutment No. 2 and piers No. 2, 3 and 4 completed.

The underpinning for the easterly half of the bridge consisted of piles placed on mud sills resting on gravel while the westerly half was as described with the piles being sunk into the hardpan. Practically no settlement was experienced in the latter but in the former there was a maximum of three quarters of an inch. Enough piling was supplied for the entire structure and enough timber for three spans which allowed the work to proceed without interruption.

Five-inch quarter dressed lumber and two-by-six-spruce was used for form work, and enough supplied for three spans. Band iron and clamps were used for form ties.

The concrete was mixed at either end and transported by buggies and duckboards. A Koehring No. 7S mixer was used. The deck and sidewalk for each span were

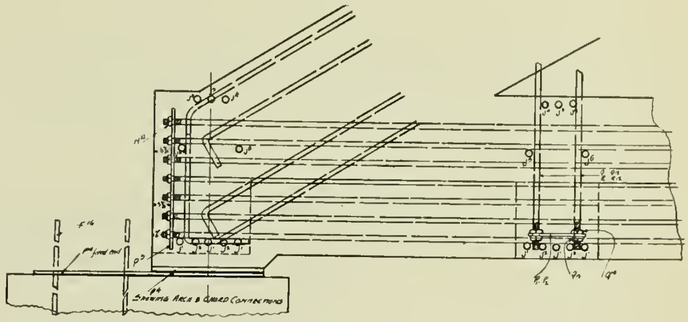


Fig. 7—Section of Arch Rib and Lower Chord.

poured without intermission and the arch ribs were poured with a small wooden tower and special bucket.

Washed sand and gravel were supplied from a local pit about one mile from the site, and the cement was used direct from a Canadian National Railways siding a short distance from the bridge. Both the cement and gravel were hauled across the ford without difficulty.

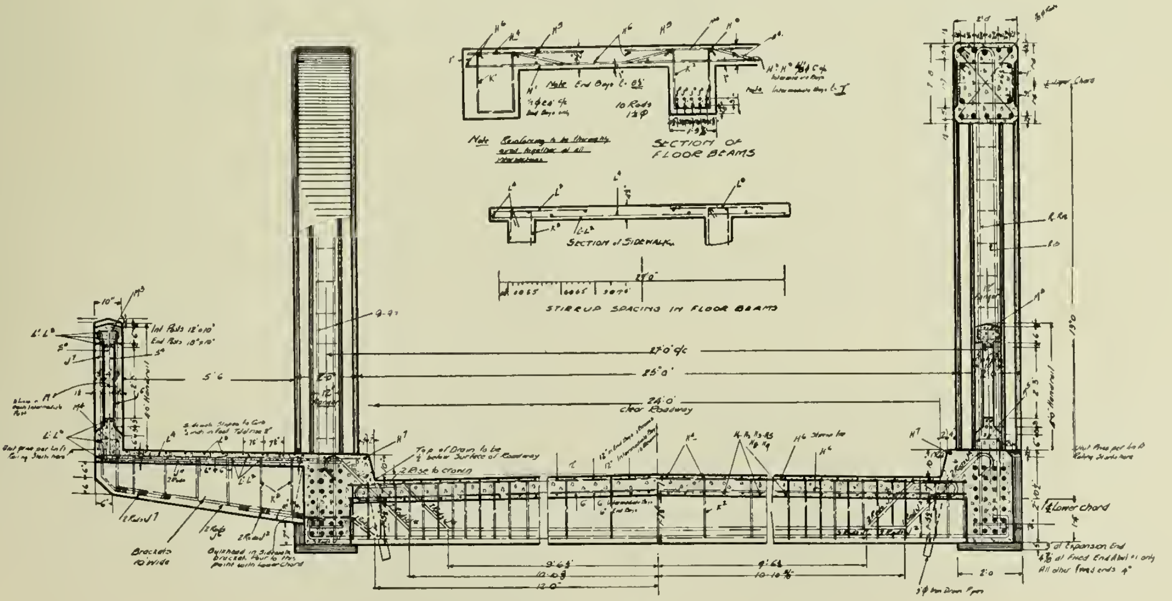


Fig. 6—Cross Section Through Superstructure.

The concrete mixes used in the structure were as follows: the mass concrete in the piers and abutments, Class C—1-2¼-3¾ for 2,000 pounds per square inch concrete, in the floor and sidewalk class B, 1-1¾-3¼ for

Fig. 8

2,500 pounds per square inch concrete, and in the arch hangers, railing and lamp-posts. Class A—1-1½-2½ for 3,000 pounds per square inch concrete. The following was the average result indicated from several tests of each class of concrete:

Class C—3,165 pounds per square inch.
Class B—2,775 pounds per square inch at fourteen days.
Class A—3,450 pounds per square inch.

The class C concrete for the piers and abutments was naturally poured much stiffer than was possible for classes B and A. It is interesting to note that the leaner and dryer concrete gave results almost as high as the richer but wetter concrete.

The contract was completed within the scheduled time and the total construction cost of the bridge amounted to approximately $68,000. The main items included were:—

Excavation for abutments and piers	1,262.4 cubic yards
Removal of old masonry and concrete	958.3 cubic yards
Island excavation	14,580.0 cubic yards
Concrete	2,680.9 cubic yards
Reinforcing steel	158.3 tons
Cement	4,400.0 barrels
Labour man-days	6,964

The cost was distributed as follows:

	Labour	Material
Federal Relief	33⅓	
Provincial Relief	33⅓	
Provincial	16⅔	50 per cent
County	8⅓	25 per cent
Kitchener	8⅓	25 per cent

The bridge was designed by and built under the supervision of the writer.

Testing and Research for the Hydro-Electric Power Commission of Ontario

W. P. Dobson, M.E.I.C.[1]

DISCUSSION

Dr. R. W. Boyle, M.E.I.C.[2]

With regard to the question of vibration of transmission wires. This is a rather serious problem as far as line maintenance is concerned and it seems it is very difficult to identify the source of vibration on the line by which the actual damage is done. As various types of vibrations can occur all at once when there is a gale or a gust of wind, where failures take place there must have been a compounding of stresses such as tension and torsion. This paper does seem to give new light and information on what may take place. Now spans have been lengthened and it has been necessary to increase the tension in the transmission wires and to reinforce the line with additional strength, therefore a steel core is used; but it seems that some research ought to be pursued by someone in an endeavour to find new alloys. A new alloy of a tougher material less subject to bend and of better torsional strength so that so much steel reinforcement would not be required. Is there anybody in the world attempting to solve this particular problem?

J. P. Henderson, A.M.E.I.C.[3]

Wind vibrations in transmission wires would seem to cause a similar problem to that encountered in the construction of aeroplanes, aeroplane struts and wires. All are familiar with the singing of the wires in the wind. Has streamlining ever been considered feasible in any way for transmission wires?

O. W. Titus[4]

The question Mr. Henderson has raised about developing a streamlined conductor has been considered in the past and there are some objections to it. Take the aeroplane: the wire is supported between two reasonably rigid supports. It cannot turn transversely to the line of flight. But with line conductors one must consider supports which are not particularly rigid and with these one thousand feet apart the stresses are somewhat complicated at a midpoint five hundred feet away.

The wires turn transversely and this increases the difficult conditions. Another objection to streamlining is that corona losses must be cut down. This would not seem to amount to much but when there is 270 miles of wire it becomes an economic factor. The most efficient way to reduce corona losses is to obtain something that is an absolutely smooth cylinder. The moment this is departed from the corona losses are higher. Streamlined types being of non-uniform cross-section, that is, not being completely circular, tend to increase the corona losses.

Another question that has been raised is the development of alloys. In this connection the manufacturer runs into a problem immediately. When you take a metal which is a very efficient electric conductor and start to mix things with it to increase its strength, you usually

[1]Paper presented at the Annual Meeting of The Engineering Institute of Canada held at Toronto, Ont., February 8th, 1935, and published in the March 1935 issue of The Journal.

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[4]Chief Electrical Engineer, Canada Wire and Cable Company Limited, Toronto, Ont.

(*Continued on page 313*)

Trans-Atlantic Air Transport

J. H. Parkin, M.E.I.C.,
Ottawa, Ont.

Paper presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, on May 11th, 1934.

SUMMARY.—The various routes for air traffic across the Atlantic are considered with respect to climatic, navigational and other difficulties, and the capabilities of existing aircraft for this service are discussed. It is suggested that there is now a favourable opportunity for the establishment of a fast air-and-steamer service and ultimately an all-air service between Europe and North America via the St. Lawrence.

Canada occupies a geographical position whose importance in connection with future air transport routes, particularly those between Europe, America and the Orient, can hardly be exaggerated. At the present time, due to the excellence of the trans-Pacific service of the Canadian Pacific steamships and of her transcontinental railways, one of the greatest trade routes between east and west lies through Canada.

With the development of air routes to the east via Europe and India, Canada is in danger of losing this traffic and the benefits accruing therefrom. However, with the proper development of air lines, the advantage will still rest with the Canadian route. There will be the additional great advantage as compared with the Europe-India route, that it will be an all-Empire route.

Examination of a map prepared on the conical orthomorphic projection will disclose important facts concerning the geographical position of Canada not generally realized from a study of a map on the Mercator projection. It will be observed that the great circle route, the shortest and most direct, between the industrial region of Europe through London to Montreal and the industrial region of North America passes via Newfoundland almost directly down the valley of the St. Lawrence. Similarly, the great circle route to the Orient from Chicago passes through Winnipeg, north of Edmonton, through the Yukon and Alaska, across Behring Straits, down the coast of Siberia and through the Japanese Islands. Canada thus occupies a key position on these routes and one which is fully realized by the powerful aviation interests already at work endeavouring to establish and dominate world air routes. In fact, Canadians perhaps least of all realize the economic importance of the position of the Dominion at the cross-roads of the future air routes of world commerce.

History shows that great trading centres always develop at the cross-roads, and modern London, New York, Hamburg, Amsterdam and Montreal all demonstrate this fact. Through traffic creates permanent trade at the junction points, and railways, hotels, merchants, and manufacturers all derive profit from the flow of commerce and passengers. Montreal, Winnipeg, Vancouver and the whole Dominion will derive manifold benefits from the flow of this international air traffic if preparations are made to take advantage of Canada's favourable geographic position and conduct future air traffic via the Dominion.

The great barrier to communication between the continents of Europe and America is the Atlantic ocean. This barrier has been successively overcome by sailing vessels, steamships, submarine cable and wireless telegraphy and telephony. It is in process of being surmounted by aircraft, since over fifty non-stop crossings have been made of the North and South Atlantic oceans. The flights of the Graf Zeppelin between Germany and Brazil are the nearest approach to a regular service as yet attempted.

To circumvent the great length of the open sea crossing, many flights have been made around the north and south of the North Atlantic and these routes and those proposed for future commercial use may be broadly classed as northern, southern and direct.

Northern Routes

The northern routes, a number of which already flown are shown in Fig. 1, touch the Shetland and Faroe Islands, Iceland, Greenland and run then either via Labrador and Newfoundland to New York or cross Davis Strait, Northern Quebec to the east shore of Hudson Bay and thence through Northern Ontario via Cochrane to Detroit or to Chicago.

In addition to its greater length, the disadvantages of the northern route, as given by Commander von Gronau, who has thoroughly explored its possibilities in the course of three flights by different routes from Europe to America via Greenland, are outlined below.

The extraordinary gustiness on the Iceland coast is notorious and fogs, typical phenomena of oceanic islands, frequently envelop the coast and hide the coastal mountains. Floating ice and icebergs are prevalent between Iceland and Greenland and may cover the entire stretch of sea even in August. The ice makes landing and taking off dangerous and difficult on the east coast of Greenland.

There are no reliable maps of Greenland and the interior is unexplored, although in recent years several expeditions have been at work. On the east coast there are only two settlements—Angmagsalik and Scoresby Sound and only one region where musk ox can exist. The east coast marginal area of fjords, high promontories, glaciers and mountain ranges, of which there are two, is some 150 miles wide. The coastal range on the west coast is of equal width with deep fjords and glaciers. The mountains range in height from 8,000 to 13,000 feet.

The inland ice region ranges in height from 9,000 to 10,000 feet. While this appears flat and an emergency landing could possibly be made with a seaplane, it is quite uninhabited and to reach the coast settlements would be difficult, in fact, toward the warmer west coast, walking is practically impossible. In the interior, low clouds, mist and snow frequently reduce the visibility to zero and conditions favourable to the formation of ice on aircraft prevail for six months in the year. There is an extensive radio dead region, of some five hours' flight, precluding receipt of weather reports or direction bearings and magnetic variations of 40 to 70 degrees render the magnetic compass of doubtful value.

The west coast is heated by the Gulf Stream to some extent and by warm air from the tropics which, under certain atmospheric conditions, penetrates these regions, so that the coast and fjords are relatively free of ice for most of the year except when southwest winds fill or block the fjords with drift ice. In the summer, there is much floating ice in the stream flowing north along the coast, which, with the cold water of Davis Strait gives rise to surface fog. Westerly winds blow this fog inland and into the open fjords. Narrow fjords, closed toward the sea by high mountains, are not penetrated by the mist and hence might serve as airports were it not for the frequent strong down-gusts within them. With east winds, the fogs remain less than a mile off shore. Fog renders points on the central and south sections of the west coast unsuitable for airports for a regular service. Ice should give little trouble. The coast in the neighbourhood of Godhaab may be regarded

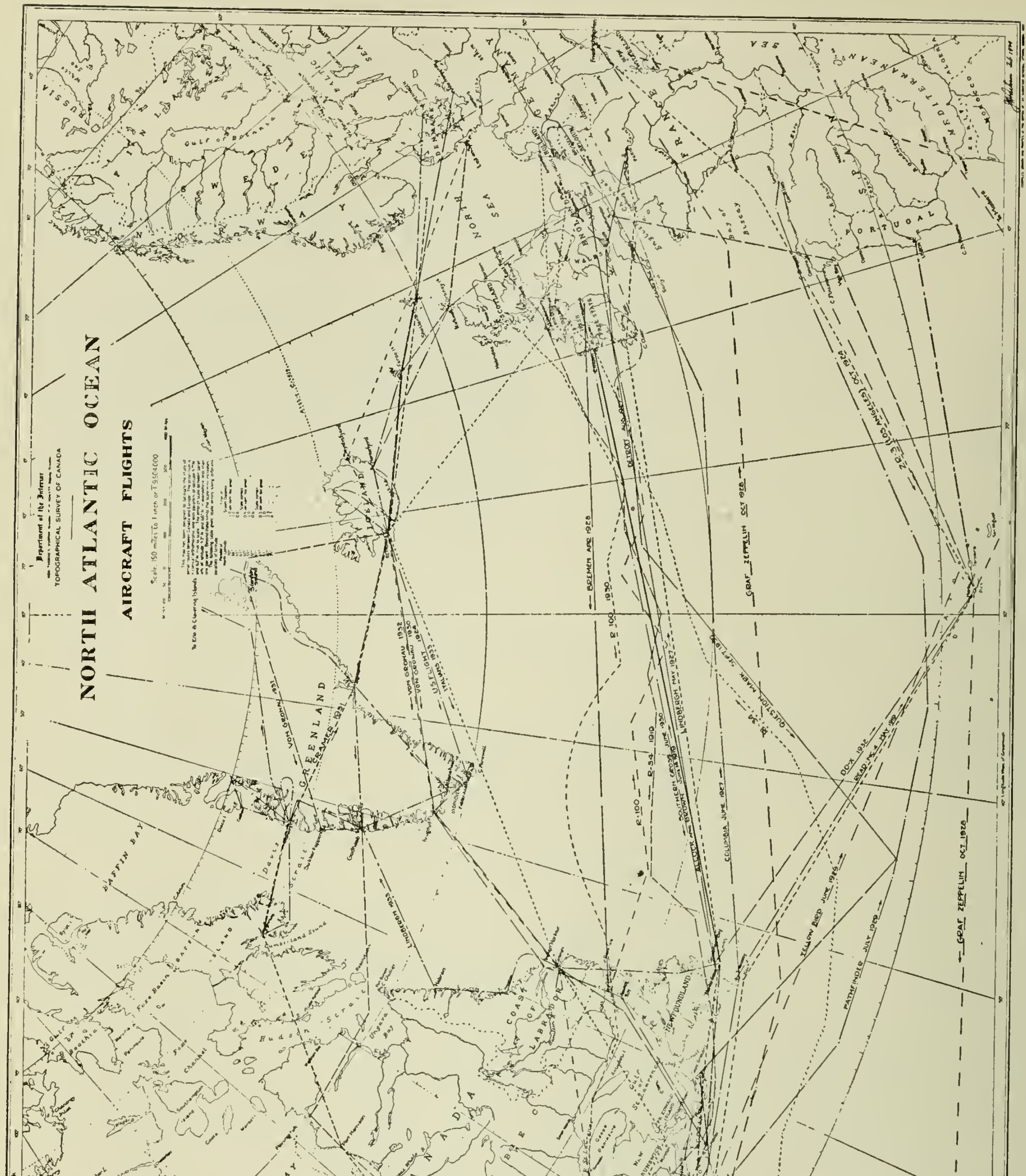
NORTH ATLANTIC OCEAN
AIRCRAFT FLIGHTS
TOPOGRAPHICAL SURVEY OF CANADA
GREENLAND
BAFFIN BAY
HUDSON BAY
NEWFOUNDLAND
FRANCE
PORTUGAL
SWEDEN
NORTH SEA
GRAF ZEPPELIN OCT 1928
BREMEN APR 1928
COLUMBIA JUNE 1927
LINDBERGH MAY 1927
YELLOW BIRD JUNE 1929
PATHFINDER JULY 1929
ALBERTA
SASKATCHEWAN
UNITED STATES

Fig. 1

as ice free as there is little drift ice this far north and the winter pack ice begins considerably to the north.

Very often weather conditions on the east and west coasts are exactly the opposite, i.e., good in the west and bad in the east.

The Davis and Denmark Straits are favoured passages through which Arctic air drains southward into the middle latitudes. The Davis Strait is a region of frequent storms, low clouds and freezing temperature except for short periods in midsummer. The northeast storms with long periods of cold rains and low visibility are particularly hazardous. Fog and floating ice characterize the Strait of Denmark.

Low pressure areas, moving across the continent from the west pass over the New England coast or Gulf of St. Lawrence and while many continue their former track for some distance over the ocean, about 50 per cent turn northward toward the west coast of Greenland or into Davis Strait. These constitute a serious storm hazard since they are preceded by strong easterly winds, low clouds and for at least half of the year by temperatures near or below freezing.

Over Labrador and Northern Quebec (Ungava) conditions are not quite as bad. However, correct maps are non-existent and even if available, the country is featureless, composed of masses of rock interspersed with thousands of water-holes and pools, all alike, rendering identification difficult. The country is uninhabited except for occasional Eskimo encampments on the coasts. The nearness to the magnetic pole results in a deviation of 50 degrees in the magnetic compass. There are occasional sandy beaches on the east shore of Hudson Bay suitable for emergency landings.

The remainder of the route is one of frequent ocean-borne storms from the southwest. Clearly defined horizons are very unusual. As a result of his experiences, von Gronau considered that the best route would be from Reykjavik to Cape Farewell and directly across to south Labrador. Given reliable organization so that help would be available in case of an emergency landing, he thought a regular route possible, but did not dare to say that it could be operated all the year round.

Lindbergh, after flying over this route, is reported as stating that there must be no forced landings. Other expeditions have reported the route very difficult.

Unknown weather is the major hazard on the Arctic routes. There are but few weather stations in these regions. The Canadian stations are along the St. Lawrence; in Greenland, there are two on each coast with one on the southern tip; in Iceland there are two and in the Faroe Islands one. There are few ships in these regions to supply weather reports. The period of daylight is very short during the winter months.

The great length of the northern routes largely offsets the greater speed of aircraft and there would be no saving in time over the present four or five day crossing in palatial steamers. The one advantage is the short stages or ocean flights. The provision of the necessary ground organization, main and intermediate landing fields, radio and meteorological services in such regions, however, presents enormous difficulties. The price of avoiding long oversea flights afforded by these routes, however, is not worth the effort, expense and discomfort.

In spite of these disadvantages, the northern route is receiving much attention and the Pan-American Airways of New York in 1932 acquired a 15-year monopoly of landing and aviation development rights in Iceland and a license to explore Greenland with a view to a Detroit-Copenhagen service.

The flights of Cramer and Pacquette (1931), Preston and Collignon (1931) and Lindbergh (1933) over these routes were made under American auspices.

Southern Routes

There are a number of so-called southern routes, that followed for the first Atlantic crossing in 1919 and on several subsequent occasions, the latest being the Italian formation flight in 1931, runs from Newfoundland via the Azores to Lisbon. Another runs from New York to the Azores, roughly following the New York-Gibraltar steamer lanes, while the most southerly is that from New York, Charleston or Norfolk via Bermuda and the Azores.

Pan-American Airways are negotiating for permission to use the Azores and Portuguese territory in connection with a regular service.

The principal disadvantage of these routes is the long sea crossings varying from 800 to 2,000 miles. The islands of Bermuda and the Azores, after flights of such lengths over sea, present very small landfalls and call for accurate navigation. In addition, there are relatively few ships in the neighbourhood of the most southern route to supply information on which to prepare accurate weather maps and forecasts.

Horta, on the southeast coast of Fayal, the only harbour worth considering in the Azores, is only useful in relatively calm weather and is none too favourable for flying boats. The harbour is considerably silted up and its effective size is much smaller than appears from the charts. It could be made an excellent harbour at considerable cost.

Weather conditions are said to be generally favourable on the southern route (Bermuda-Azores) for all year round flying. The air is generally clear, fogs are infrequent and over most of the course the winds are not stormy. There are tropical cyclones which usually occur in late summer and autumn and cannot be foreseen since they originate south of the Bermuda-Azores line, in a region rarely traversed by ships. Local thunderstorms also occur. In daylight these disturbances may be avoided, but at night their course and extent are difficult to estimate.

The best known storms forming over the warmer parts of the ocean are the hurricanes. As a rule, they appear in the doldrum area, travelling first in a westerly direction, then turning to the north on some meridian west of Bermuda and finally to the northeast. Many of these leave the tropics between Bermuda and the Azores. They usually form in the late summer. Those of the early part of the season originate near the Azores and proceed on a course north of west before leaving the tropics to join in the eastward procession. After August, they form in mid-ocean. No doubt many lesser storms and some severe ones come north from the southern portion of the ocean at other times of the year as well. Severe storms often breed over the coastal waters south of Hatteras and are rejuvenated continuously as they follow the Gulf Stream, often acquiring sufficient energy to carry them across the ocean.

Of some thousands of ocean storms studied, only 10 per cent were traced from one continent to the other, 21 per cent were observed on one coast or the other and 32 per cent of those that reached Europe were ocean born.

Weather maps indicate that slightly north of the direct Bermuda-Azores line the prevailing winds are light westerly and northwesterly and a little south of the line the winds are light northeasterly, calm or light westerly. By flying somewhat south of the direct course on westerly flights and north on easterly flights, advantage could be taken of favourable winds. From New York to London via Bermuda and the Azores is 4,700 miles approximately.

The route from New York, following the steamer lane for some 1,200 miles and then via the Azores to Vigo or Corunna possesses many desirable features, but is long and requires accurate navigation. From New York to London via Vigo is some 4,200 miles by this route. Compared with the direct Great Circle route, it is less stormy, less cloudy and lies south of the fogs of the Grand Banks. Weather

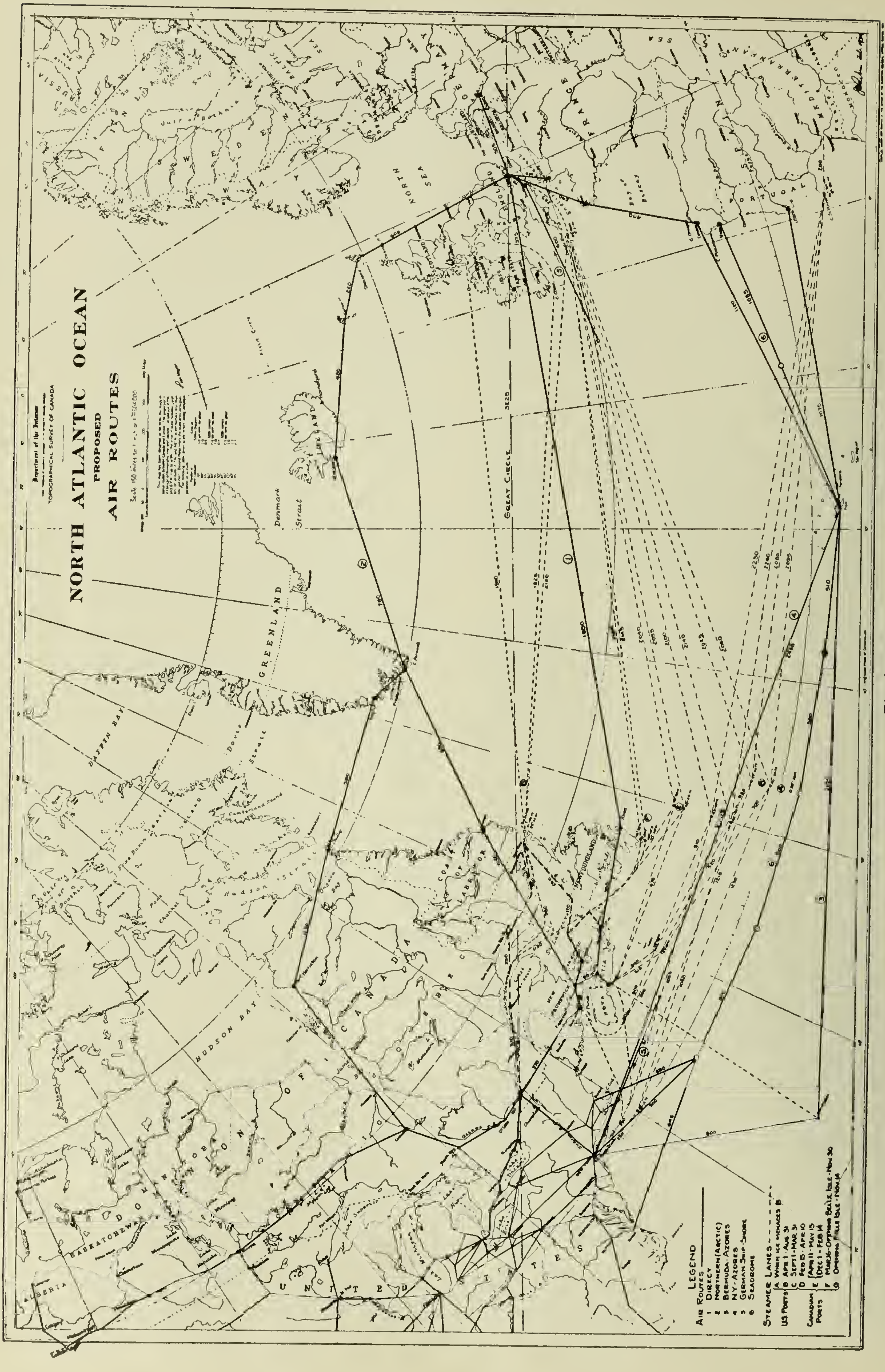
NORTH ATLANTIC OCEAN
PROPOSED
AIR ROUTES
Department of the Interior
TOPOGRAPHICAL SURVEY OF CANADA
LEGEND
Air Routes
1 Direct
2 Northern (Arctic)
3 Bermuda-Azores
4 N.Y.-Azores
5 German Ship-Shore
6 Seadrome
Steamer Lanes
GREENLAND
ICELAND
NORTH SEA
FRANCE
PORTUGAL
SWEDEN
NEWFOUNDLAND
HUDSON BAY
BAFFIN BAY
Denmark Strait
Davis Strait
GREAT CIRCLE
UNITED STATES
DOMINION OF CANADA
SASKATCHEWAN
ALBERTA

Fig. 2

information may be had all along this route. If radio-equipped, aircraft may always be able to reach assistance within a few hours' flying. It has much promise as a two-way route even in winter.

Two proposals have been made to overcome the handicap of the long ocean flights of the southern route, one using seadromes and the other the ship-to-shore service.

Seadromes

Floating islands, by providing refueling facilities at short intervals, reduce the necessary fuel load with a corresponding increase in pay load. The United States government in 1933 voted some $1,500,000 for the construction of a quarter-section of one of the so-called Armstrong seadromes. If tests with this are successful, it is proposed to build a complete unit at a cost of $6,000,000 and contingent upon its success, a total of five are proposed to be anchored at not less than 500-mile intervals between New York and the Azores along the 39th parallel of latitude and between the Azores and Vigo, Spain.

The landing-deck of the seadromes is to be 1,000 by 300 feet, supported 100 feet above the sea on a structure incorporating twenty-eight buoyancy tanks floating about 100 feet below the surface to avoid wave action and another 100 feet below which are ballast tanks. The tank columns (streamlined in the region of wave action) are some 300 feet in overall length and are interconnected by tubular struts and cables. The structure is anchored to the sea bottom, which will be as much as three miles below the surface. The proposed seadromes are provided with hangars, hotel accommodation, etc., below the flying deck. The normal population of each seadrome would be about one hundred and twenty-five, with hotel accommodation for three hundred.

It is considered that there would be considerable difficulty in landing aircraft on this relatively small platform in fog or unfavourable weather, even with modern blind-flying facilities. To avoid this trouble insofar as possible, it is proposed to anchor the seadromes in regions least susceptible to fog.

The chief objection to the floating island plan, since it appears technically feasible to construct the enormous floating platforms of sufficient strength, although anchoring them presents difficulties, is the enormous cost, some $50,000,000 for the whole undertaking. This is a serious handicap to the operation of a commercial air route on an economic basis. Assuming aircraft capable of carrying one ton of payload for 500 miles between the seadromes, it would appear much cheaper to employ four or five times the number of aircraft, each carrying a payload of only 400 to 500 pounds over the 2,000 miles between Newfoundland and Ireland.

From an aeronautical viewpoint, the seadrome is an evasion of the real problem, namely the provision of a land-to-land service without intermediate landings.

Ship Refueling and Launching

Germany has been trying out a somewhat similar plan in the South Atlantic. The ship, *Westfalen*, equipped with catapult and a special trailing apron was stationed midway between Bathurst, Gambia and Natal, Brazil. In landing, in rough weather, the ship steams slowly into the wind, trailing the fabric apron behind. The flying-boat lands and taxies up on the apron, is lifted aboard, refueled and launched by catapult.

The first flight was made in June 1933, from Berlin via Cadiz-Bathurst-Westfalen-Natal, the ocean stage taking fifteen hours five minutes.

Ship-to-Shore Service

In 1928, the *Ile de France*, of the French line, was equipped with a catapult for a ship-to-shore service. The Germans, in co-operation with the French and Swiss, have operated since 1929, during the summer months, a ship-to-shore service for first class mail between Southampton and New York. The liners *Bremen* and *Europa* are equipped with catapults. On the western trips, the Heinkel seaplane, carrying 300 to 400 pounds of mail, is catapulted from the liner at distances varying from 70 to 1,545 miles from shore, depending on weather conditions, generally 600 miles out, off the Nova Scotia coast, and flies to New York. In some cases, Canadian mail is landed at Halifax before proceeding to New York and stops are sometimes made at Boston. Of seventeen such flights made in 1931, savings in time ranged from zero to seventy-two hours.

On the eastbound trips, the aeroplane leaves the liner some 500 to 600 miles out and flies to Southampton from which the mail is carried to Croydon and flown thence to Cologne. Of sixteen flights in 1931, thirteen showed an average saving in time of forty-seven hours. It was proposed to extend this service to include despatch of mail by seaplane from shore to overtake the ship some 600 miles from shore.

There were several serious accidents in this service, in which pilots, machines and mail were lost and it was considered so hazardous that neither the British nor United States post offices will have anything to do with it. There is also the consideration that the catapults take up valuable space in the liners. The arrangement provides a five-day service between London and San Francisco.

Direct Route

There remains the direct great circle route from Montreal to London via Newfoundland and Ireland, which possesses the great advantage of being wholly British.

At the present time, the fastest crossing by ship, the *Empress of Britain*, from Southampton to Quebec, is four days, twenty-three hours, forty-eight minutes, at an average speed of 24.8 knots (1932). By taking the mails off at Belle Isle and flying them to Montreal, a saving of about thirty-six hours has been effected and the time between London and Vancouver reduced to five days, seventeen hours.

Experimental Ship-to-Shore Services—St. Lawrence

During the summer of 1927, experimental flights made by the Department of National Defence, conveying British and Foreign mails between Montreal and Father Point near Rimouski to connect with liners, demonstrated that from twenty-four to seventy-two hours could be saved in the delivery of incoming and outgoing mail. As a consequence, a regular contract air mail service between Rimouski and Montreal was commenced on May 5th, 1928, and has been operated each summer since then, with great success, up to 800 pounds of mail per trip being carried.

The success of this service led to the laying of plans for its extension to Bradore Bay on the Strait of Belle Isle, just within the Canadian boundary. The first experimental flight over the extended route was made by two seaplanes of Canadian Airways in 1930. Carrying 1,000 pounds of mail, the machines left Quebec at 8.30 a.m. and arrived at Bradore, 785 miles distant, at 5 p.m., where, despite adverse weather conditions, the mail was transferred to the *Empress of Australia* which had left Quebec the day before, thus effecting a clear gain of twenty-four hours.

During the Ottawa Imperial Conference in 1932, a series of ten experimental flights were made between Red Bay on the Strait of Belle Isle and Ottawa, to provide faster mail service for the Conference and to determine the commercial feasibility of the service. The mail left London at 2 p.m., was flown to Cherbourg and placed on the *Empress of Britain* which sailed at 6.30 p.m. From the *Empress*, passing Red Bay about 2.30 a.m. of the third following day, the mail was transferred to a seaplane by naval tender, without deviation or appreciable delay to the *Empress*. The mail was flown 386 miles in four hours to Havre St. Pierre (opposite Anticosti), transferred to a flying boat and flown 290 miles in three and a half hours to Rimouski and again transferred to a landplane and flown 314 miles in three and a half hours to St. Hubert (Montreal) reaching there at 4 p.m. of the fourth day. After sorting, the American mail was placed on the regular aeroplane for Albany and the Ottawa mail flown to Ottawa, covering the 110 miles in one hour, arriving at about 5.30 p.m. The 1,100 miles was covered in a flying time of twelve hours and an elapsed time of fifteen hours, the elapsed time from London being one hundred hours, resulting in a gain of thirty-six hours. Eastbound, the mail left Ottawa at dawn, reaching Red Bay at 5 p.m. to connect with the *Empress* passing at 8.30 p.m., having left Quebec the day before.

This schedule was well maintained during the Conference and mail posted in London was delivered as follows:—

Montreal	—4 days	6 hours later	
Ottawa	—4 "	8 "	"
New York	—4 "	10 "	"
Vancouver	—6 "	7 "	"
Los Angeles	—5 "	10 "	"

Alternative Routes—Ship-to-Shore Service

It was found, in operating the Belle Isle service in 1932, that fogs were prevalent along the north shore of the Gulf from Cape Whittle to the Strait and aircraft had difficulty getting through from Montreal to the Strait, although the westbound flight from the Strait was readily made. At the same time, the west coast of Newfoundland is said to be relatively free from fog and an alternative route to that following the north shore and thence to Rimouski is to fly the mail down the west coast of Newfoundland, dropping the Newfoundland mail at St. George's Bay for transfer to the Newfoundland Railway and thence via Cape Ray, Magdalen Islands, Prince Edward Island and Shediac to Moncton and via the trans-Canada airway to Montreal. The route possesses the advantages of established airports and ground organization over a large part of it. Further, as ice limits the use of the Straits of Belle Isle to about five months in the year, during the remainder of the open season the transfer from ship to plane could be made in Cabot Strait, off Cape Ray (possibly Cape Race and fly to Sydney) and the same route followed to Montreal. In winter, the mail would be transferred from ship to aeroplane at Halifax or St. John. The suggestion that the mail should be transferred, in winter, at sea, off Halifax, does not seem feasible. Experience will quickly show the most practical route or routes down the St. Lawrence, all of which possess the great advantage that nowhere are the machines out of sight of land.

Fig. 3—Junkers G 38 Monoplane.

Possibilities of Combined Air-Steamship Service

The St. Lawrence route between Europe and America, the shortest of the North Atlantic routes, lends itself admirably to a combined air and steamship service. From Southampton to Montreal is 3,343 miles, of which 1,100 miles are within sheltered waters.

The success of the experimental services, operated with slow and unsuitable machines and insufficient ground organization and radio service, has demonstrated beyond doubt the practicability of such a ship-to-shore service and the experience gained in operating the services will be invaluable in planning a practical air mail connection between London and Montreal. With fast aircraft, suitable equipment and adequate organization, by flying the mail from London to Southampton, placing it on a fast ship for carriage to Belle Isle, transferring there to aircraft and flying to Montreal, a 4-day service between London and Montreal and a four and a quarter-day service between London and New York are quite feasible.

With a regular combined air and steamship service in operation, via the St. Lawrence, effecting savings in time of twenty-four hours and upward between Europe and points in America, the flow of mail will undoubtedly be diverted to this route despite the greater frequency of sailings on the present New York route.

Trans-Atlantic Distances (approximate)
Land Miles

(A) *Steamers*			
Montreal-Southampton	via	Belle Isle	3,325
" "	"	Cabot Strait	3,510
Halifax- "	"	track E	2,960
St. John- "	" "	CD	3,355
New York- "	" "	CD	3,630
(B) *Aircraft*			
Montreal-London	via	Great Circle	3,225
	"	Newfoundland-Ireland	3,380
	"	Iceland-Greenland	3,800
New York-London	"	St. Johns	3,475
	"	Azores, Corunna, Brest	4,245
	"	Bermuda-Azores	4,760
	"	seadromes-Vigo-Brest	4,360

The Complete Air Service

The great circle distance from London to Montreal is some 3,225 miles, of which 300 to 400 is between London and Ireland and about 1,000 miles between Newfoundland and Montreal, leaving only 1,700 to 1,800 miles of open sea distance between Ireland and Newfoundland. Much would be learned by operating initially a ship-to-shore service at both ends of this route. There is no doubt, after the success attending the experimental services already operated, that such services, in a few years, could be run regularly and satisfactorily. By that time, suitable aircraft for the trans-Atlantic service would be available and the complete London-Montreal air service could be placed in operation.

Great Circle Route

The great circle Atlantic routes between Newfoundland and the British Isles are, of course, the shortest between terminals. Aside from the length of the oversea flight, the great disadvantages are those due to the weather. The prevailing winds are westerly, varying from southwest to northwest. The routes pass through the zones of greatest storm frequency and thickest clouds and the Newfoundland fogs. The region is one of the most completely overcast areas in the northern hemisphere and about one-half the observations from ships on the great circle course report precipitation.

Conditions favourable to the formation of ice on the aircraft are frequent. Pilots flying in midsummer, well south of the steamer lane and at otherwise desirable flying levels, have encountered ice. In summer, temperatures range from around 40 degrees near Newfoundland to over 70 degrees. Flight at high altitudes would encounter steadier and stronger westerly winds, the prevalence of clouds would necessitate blind flying and the thick cloud banks reported by many pilots suggest freezing temperatures and ice formation in their upper levels, even in midsummer.

As already mentioned, most American storms enter the Atlantic from the Newfoundland area. Only a few continue on the easterly course to Europe. About half turn toward the west coast of Greenland and Davis Strait. The remainder reach a point of dispersal southeast of Greenland, whence most continue toward the British Isles, while some turn northeast toward Ireland and a few bear off southeast.

An advantage of the route, since it approximates the steamer lanes, is the wealth of weather reports available from the ships. In one day, reports were received from over twenty vessels in this region.

While prevailing currents of winds and water, and the average tracks of storms, and the areas of greater gale frequency have been established for the shipping zones, the weather information and maps are as yet inadequate for scheduled Atlantic air route operation. Upper air observations of temperature, wind and cloud are necessary, but there is at present no feasible method of obtaining such information. Eventually, the accumulation of information from many flights across the ocean will be a source of much needed information.

Means of Surmounting the Ice and Fog Hazards

In surmounting the fog difficulty, the fog- and haze-penetrating properties of infra-red rays may prove of value. A recent development for use on ships is a camera using infra-red sensitive plates, taking photographs forward in the direction of the ship's course. The photograph is available in about a minute and, in foggy weather, provides the ship's officers with a view, through the fog, about one mile ahead. This, of course, is too slow for aircraft use.

In the case of ice formation, there are certain factors which render the problem less difficult than appears at first glance:—

(*a*) The critical temperature for ice formation on aircraft is near the freezing point. In very cold weather, ice does not adhere. For this reason, aircraft operating in the United States experience more trouble from ice than in Canada.

(*b*) The ice generally builds up on the forward portions of the wings, struts and other parts of the machine.

(*c*) To prevent the formation of ice on the aeroplane, it is only necessary to maintain the surface at a fraction of a degree above the freezing point. This has been proved in the freeing of hydro-electric plants of the ice trouble.

Hence, the areas to be heated and the amount of heating required are not as large as might be expected. The exhaust gases, or a medium heated by the exhaust gases, are possibilities for the heating of the leading edges of the wings and tail surfaces. Struts, in modern machines, are few in number and will doubtless eventually disappear entirely. Electric heating, as in power plants, is also a possibility. In the United States, a rubber "overshoe" for the leading edge of the wings has been tried. This overshoe can be inflated to dislodge ice when it forms.

While the fog and ice hazards are admittedly serious, they are by no means insurmountable, given suitable machines and adequate ground, meteorological and radio services. There is a good deal of fog in England and on the Paris-London route and yet this service operates with excellent regularity and there are few cases of interruptions due to fog. In fact, on occasions, aircraft have got through when there was a complete tie-up of shipping.

In any case, the planning of air services to avoid fog and ice troubles is evading the issue. Means must be devised and will be devised to overcome these hazards and enable aircraft to operate irrespective of such weather conditions. If fog had been allowed to divert shipping, the St. Lawrence route would not be the important shipping lane it is today.

Fig. 4—Fairey Long Range High Wing Monoplane.

Capability of Existing Aircraft

Because of the prevailing westerly winds and of the fog and ice hazards, most of the stunt crossings of the Atlantic have been from west to east, generally from Newfoundland to Ireland. Some flights have been made by the southern route via the Azores. In most, if not all cases, the machines making these flights have been so loaded with fuel that there was little margin of safety and no pay load. In fact, difficulty was generally experienced in getting off the ground and, in not a few cases, failures occurred during the take-off. No machine so loaded would be permitted to operate on a commercial air route. This fact does not mean that there is no machine at present capable of flying the Atlantic with a pay load and the required margin of safety. Several machines have flown 5,000 to 6,000 miles non-stop. If, in such a machine, only half the gasoline supply for 5,000 to 6,000 miles is carried, the machine will have a range of 2,500 to 3,000 miles with a fair pay load and such a machine could make the flight from Newfoundland to Ireland with 500 to 1,000 miles to spare for emergencies. This being the case, it is reasonable to expect that, within a few years, aircraft will be regularly flying between England and Canada.

In the following table are listed a number of present-day aircraft capable of flying the Atlantic with a pay load. The range, as given by the makers, is tabulated, together with the actual range attained, and a range estimated for purposes of this paper, in a rough approximate way, described later. In addition, assuming a required range of 2,500 miles for the Ireland-Newfoundland flight, based on about 2,000 miles of distance and a 30-mile per hour head wind, the pay load has been estimated approximately.

The range calculations have been based on:—

Data as given in Jane's "All the World's Aircraft," 1933.

Initial fuel and oil consumption—gasoline engines, 0.5 lb. per h.p. per hr.

Initial fuel and oil consumption—oil engines, 0.4 lb. per h.p. per hr.

Weight of crew—160 lb. per man.

To avoid going into too great detail and the use of cumbersome formulae, the calculations have been based on the following assumptions:—

Average cruising speed, 85 per cent of maximum speed.
Average cruising engine power, 90 per cent of normal rated power.
Average specific fuel consumption during flight, due to lightening of aircraft as fuel is consumed, 90 per cent of initial consumption.

Based on the foregoing, the fuel consumption employed, based on normal rated engine power, were:—

For gasoline engines—0.40 lb. per h.p. per hr.
For oil engines—0.32 lb. per h.p. per hr.

The agreement between ranges, as given by the builders and as calculated by the foregoing method, is generally sufficiently good for the purpose. When large differences occur, they are generally due to either the maker's range being based on the aircraft with normal pay load or on the aircraft stripped for record flights and loaded beyond airworthiness requirements, whereas the ranges here calculated are for the machines in which the disposable load comprises fuel, oil and pilots.

At the present time, there is considerable activity, principally in France and the United States, in the construction of aircraft for trans-Atlantic service. France is interested in the postal service to South America and is preparing to replace the present steam packets operating between Dakar and Natal by aircraft. The following machines have been built in France with this end in view:—Latécoère (Croix du Sud), Bleriot 5190, Couzinet (Arc en Ciel) and Lioré et Olivier H-27. In America, a large Sikorsky flying boat for trans-Atlantic operation is under construction.

Fig. 5—Junkers Ju 52 Low Wing Monoplane.

Germany and Italy are also planning air mail services to South America.

Type of Aircraft

There is some difference of opinion regarding the type of machine that should be used for the ocean flight. Some

Aircraft Capable of Flying the North Atlantic (Ireland-Newfoundland)
(Approximate Figures)

Aircraft	Type	Engine		Weights				Cruising Speed	Range (Still Air)			Atlantic—2,500 miles		
		No.	Power	All Up	Bare	Disposable	Disposable less crew		Rated	Actual	Calculated	Time	Fuel	Pay Load
					Flying Boats									
Bleriot 5190	Mono	4	650	49,500	24,640	24,860	24,220	120	1,990[1]	.....	2,800	20.8	21,600	2,620
Latécoère 30-1	Mono	4	650	50,600	24,900	25,700	25,060	120	2,980	2,675[2]	2,890	20 8	21,600	3,460
Latécoère 50-0	Mono	3	400	21,650	9,780	11,870	11,550	110[3,4]	2,980[4]	.....	2,640	22.7	10,900	650
Liore et Olivier H-27	Mono	4	650	40,040	.....	.....	.....	130[3]	2,484	.....	.....	.....	.....	.....
Dornier Wal 1933	Mono	2	600	22,040	12,340	9,700	9,060	130	2,230	.....	2,450	.....	.....	.....
Dornier DOX 1930	Mono	12	625	123,200	68,000	55,000	54,000	104[11]	2,000	1,450[11]	1,750	.....	.....	.....
					Land Machines									
Fairey Long Range	H.W. Mono	1	530?	19,050	.....	.....	13,500	93[5]	.....	5,340[5]	.....	27[5]	6,400[5]	7,100
Bernard 81 GR	H.W. Mono	1	650	20,380	7,270	13,110	12,790	98	6,210	.....	4,820	25.5	6,630	6,160
Bleriot 110	H.W. Mono	1	600	18,920	5,500	13,420	13,100	116[3]	7,825	6,575[6] 5,634[7]	6,300	21.5	5,170	7,930
Couzinet 70	L.W. Mono	3	650	37,000	16,100	20,900	20,260	147	4,230	2,633[8]	3,820	17	13,300	6,960
Couzinet 33	L.W. Mono	3	120	7,955	3,632	4,323	3,843	105	3,350	.....	2,740	24	3,430	410
Latécoère 28-5	H.W. Mono	1	650	12,523	6,367	6,156	5,836	125	3,290	1,970[9]	2,800	20	5,200	630
Junker G-38	Mono	4	600[10]	52,900	32,800	20,100	19,140	129	.....	.....	2,860	19.5	16,750	2,390
Junker Ju-52	L.W. Mono	1	600[10]	16,740	8,710	8,030	7,710	112	1,240	.....	4,500	22.4	4,300	3,410
Northrup Victoria	L W. Mono	1	550	7,000	3,600	3,400	3,240	182	2,100	.....	2,680	14.3	3,150	90

[1] Against 31 m.p.h. head wind.
[2] Croix du Sud, Marseilles-St. Louis, Senegal 1933—22 hr. 33 min.; St. Louis-Natal, Brazil, Jan. 1934—1,970 miles—18 hrs. 17 mins.
[3] 85% of rated maximum speed.
[4] Service Technique Test Figures.
[5] Based on record South African flight, Feb. 1933—57 hrs. 25 mins.
[6] Closed circuit record March 1932. Duration record Dec. 1930—67 hrs. 53 mins.
[7] New York-Rayak, Syria, Aug. 1933—Approx. 54 hrs.
[8] Istres-Port Etienne, Jan. 1933. During flight France to Rio.
[9] St. Louis, Senegal-Port Natal, Brazil, May 1930.
[10] Junker Jumo. Oil Engines.
[11] Actual figures of Europe-South America-North America flight—(Newfoundland-Azores), 1930-32. All up weight, D V L rating for freight—123,200 lbs.

maintain that land machines should be used, while others favour the flying boat. In the former case, the flight would be made between an airport in Ireland and one in the interior of Newfoundland, and in the latter, between ports on the coasts. Newfoundland offers many protected waters around the coast for landing seaplanes or flying boats and there are many lakes in the interior. In Ireland, it would appear that the most suitable localities for landing would be the flat country near Galway or Limerick (south of the Shannon) since there are no mountains between these districts and the sea. The area immediately west of Dublin might also be used, or in the neighbourhood of Cork, although the highest mountains in Ireland are to the west of Cork.

It is claimed that land machines may well be used, since the seas in the North Atlantic, during a large part of the year, would be equally destructive to either a land plane or a flying boat, in the event of a forced landing at sea. On the other hand in 1931, a German all-metal aeroplane (Junker W-35 land machine) was forced down near Newfoundland on an east-west trans-Atlantic flight from near Lisbon and remained afloat in a fairly heavy sea for nearly a week, the crew of three being eventually rescued. On the whole, the flying boat would seem to have a better chance of surviving a forced landing. However, the important point is that machines must be so constructed and operated that forced landings do not occur. With multi-engined aircraft, there is no reason why forced landings should be any more frequent than are losses of trans-Atlantic liners.

By virtue of her favourable geographical situation, Canada is afforded an opportunity which should not be missed to establish first, a fast air-steamship service between Europe and America via the St. Lawrence and ultimately, an all-air service via the same route. The benefits to be derived from the establishment of such services will be such as to more than compensate for the cost and effort required.

DISCUSSION

(*Continued from page 304*)

cut down its conductivity or rather increase the resistance. There have been a number of conductor alloys developed but all have seemed to encounter this problem. There have been alloys developed and utilized in England, alloys of aluminum, but these apparently have not taken hold here.

J. W. Purcell, A.M.E.I.C.[5]

Our research doesn't go quite far enough. For example, in connection with soil heating research, it involves a number of problems that are not electrical nor mechanical. While electric soil heating does not involve extensive engineering, it will be used extensively and the ultimate load assume proportions that are perhaps startling. Therefore, engineers should co-operate with agricultural specialists and the farmer to solve these problems.

W. P. Dobson, M.E.I.C.[6]

Dr. Boyle refers to the complicated stresses which occur in vibrating transmission line conductors. A good deal of attention has been devoted to this by mathematical physicists but no complete solution has been obtained. It is believed, however, that the instrument which has been developed by the Commission's Research Committee gives reliable information about these stresses. There is certainly a need, however, for more extensive theoretical work in this field.

There are two main divisions in this problem. The first has to do with determining and recording the vibrations and the development of means to absorb their energy. There is also the question of effecting improvement in conductor materials. This is distinctly a manufacturer's problem but the user can from his studies determine the necessary characteristics which a material should possess.

In the construction of the Boulder dam transmission line a copper conductor of special type is being used which it is claimed will not vibrate. This result is accomplished by developing a new design of conductor. Much can without doubt also be accomplished in the development of materials more resistant to vibration than those now in use.

In reply to Mr. Henderson the author stated that experiments had been performed on conductors of different shapes and it was found possible to practically eliminate vibration with some of these shapes. Most of them, however, could not be incorporated in present types of construction without considerable change in fittings, etc. Some work had also been done in injecting viscous material between the conductor strands and some success had been obtained in this direction. Mention had already been made of the Boulder dam conductor. The main lines of attack had been first to find a conductor that would not vibrate; to produce a conductor which would absorb the energy of the vibrations; or to add something to the conductor which would absorb or diminish the vibrations. A large number of devices had been developed with this last purpose in view.

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The King's Silver Jubilee

The wave of enthusiasm which swept over the British Commonwealth of Nations on May the sixth was worthy of the historic occasion which was its cause.

The most striking feature of the demonstrations was their spontaneity, voicing as they did the loyalty and devotion of all parts of the Empire. Their extent and sincerity must have deeply touched the sovereign whose simple unaffected messages to his peoples have shown so clearly his unceasing regard for their welfare, his high sense of public duty and the share which he has always taken in their trials and difficulties. A statesman who has been privileged to know His Majesty well has spoken of him as "the King whose life is spent for his peoples and who has no thought of self. He embodies the simple ideals which are the real achievements of the race . . . As his reward, he has the loyalty and affection of his many peoples all over the world."

Nor is this esteem limited to citizens of the Empire. In the recent celebrations a particularly welcome note was sounded in the congratulations and friendly messages which came from the United States and the kindly sentiments expressed editorially in so many of its leading papers.

In Canada we may feel justly proud of the manner in which the country's loyalty has been manifested. Over the whole Dominion—on Parliament Hill and in all the centres of population—there has been nothing artificial about the homage universally offered to the King and Queen on their silver jubilee.

Twenty-five years ago there still remained something of the feeling of stability which characterized the closing years of the nineteenth century. Vital changes in social and industrial affairs seemed unlikely, and the future seemed full of promise. Trade and commerce were active, and in applied science and engineering new avenues of development were opening on every side. Physicists and chemists were making great strides, but there was as yet comparatively little co-operation between industry and science, and industrial research was only just commencing. The mechanization of industry was practically in its infancy. Bleriot had just flown across the English Channel, and while there were automobiles on the roads, hardly anyone anticipated the coming revolution in road transportation, or the extraordinary results which were to follow the development of the internal combustion engine. The steam turbine was beginning to replace the reciprocating engine for power generation. The steel industry was being revolutionized by new methods of production, and more complete knowledge of the properties and possibilities of the material, and the replacement of coal by oil fuel, which was to have such far-reaching social and economic effects, had just begun in Britain. Advances in fuel technology had commenced, leading to remarkable increases in fuel economy, and the better utilization of fuel resources.

In the field of land transportation the railway was still supreme. At sea the speed, size and power of ships was increasing, and special types of ship such as the oil tanker and refrigerated meat carrier were beginning to appear.

In communication, the electronic valve was making continuous wave radio transmission commercially possible, and was about to lead to great extension in the power and range of telephony.

In Canada the development of our national resources had already broadened out during the first decade of the new century, notably as regards hydro-electric power, the mining industry, and agriculture in the west. The first years of King George's reign saw a continuation of these peaceful activities which were violently transformed by the advent of war. There was an immediate recognition of the utility of the engineer and his scientific training, whether on the firing line or at home. At the front, new technical problems were continually presented, and had to be solved by the best means available at the moment. At home, mass production of munitions had to be developed almost over-night. New materials and processes were called for and were needed without delay, transportation of men and supplies by sea and land had to be improvised and safeguarded, and in Canada, as in Britain, we were plunged into all manner of essential industrial problems and undertakings. Members of The Institute of all classes took a worthy part in this work, both overseas and on this side of the Atlantic.

The post-war period was one of remarkable engineering development in Canada. Hydro-electric undertakings aggregating some 5,000,000 h.p. were installed between 1920 and 1930. The construction industry grew rapidly until in the year 1929 nearly $600,000,000 were expended on such work. The provinces embarked on the construction of thousands of miles of new highways and the rebuilding of existing roads, the railways carried out an ambitious programme of extension, and the mining, metallurgical and chemical industries showed rapid growth.

Some idea of the rate of this progress may be gleaned from the facts that the total power installed in manufacturing industries and in central stations in Canada increased from about 4,000,000 h.p. in 1921 to over 11,000,000 in 1930, while during the same period the power generated by internal combustion engines, largely for motor traction purposes, rose from a negligible amount to an estimated total of over 60,000,000 h.p.

No outline of engineering activities in Canada in the past fifteen years would be complete without mention of the progress made in those branches of engineering work which bear directly upon public health and the amenities of life; as regards water supply and sanitation great advances took place, not only in the larger cities but in the smaller towns and rural districts.

In Canada, as in other countries, the last quarter of a century has seen the rise of many highly specialized branches of engineering work related to the numerous new processes, methods or materials which have been developed and to new activities in transportation and communication. To take only one or two examples, the work of the chemical engineer, the welding engineer, or the radio engineer calls for new and highly specialized training. Accordingly the scheme of engineering education has broadened and undergone a development not less striking than the changes in engineering and industry which have caused it. The engineering schools have grown in efficiency, in numbers of students and in diversity of subjects taught.

The peak of all these activities was reached in 1929, and the course of events since that time is fresh in our minds. In Canada, as elsewhere, the years of depression have checked development for a time, but there are now definite signs of revival.

After thus reviewing the record of the past twenty-five years, and noting the political and social turmoil of the post-war period, it seems hardly possible that later generations can have any experiences more stirring than have fallen to the lot of those of us who have witnessed the dramatic events of the years following the accession of King George V.

OBITUARIES

Harald Leicester Leverin, Jr.E.I.C.

Deep regret is expressed in placing on record the untimely death, in an automobile accident, on May 14th, 1935, of Harald Leicester Leverin, Jr.E.I.C. Captain Leverin, who was stationed at Work Point Barracks, Esquimalt, B.C., was driving into Victoria when the fatal accident occurred.

Captain Leverin was born at Sault Ste. Marie, Ont., on September 22nd, 1905. He received his early education at Ashbury College, Ottawa, and graduated from the Royal Military College, Kingston, in 1928, and from McGill University, with the degree of B.Sc., in 1930. He also attended the School of Military Engineering at Chatham, England. Following graduation Captain Leverin was attached to the Royal Canadian Engineers as works officer, at Quebec, and in 1931-1932, was assistant works officer at Halifax, N.S. In 1932 he was transferred to Esquimalt, B.C.

Captain Leverin joined The Institute as a Student on February 4th, 1930, and transferred to the class of Junior on September 21st, 1934.

Charles Melville Macreath, A.M.E.I.C.

Regret is expressed in placing on record the death at Sault Ste. Marie on May 12th, 1935, of Charles Melville Macreath, A.M.E.I.C.

Mr. Macreath was born at Glasgow, Scotland, on June 25th, 1878, and received his early education at the Glasgow and West of Scotland College, later serving a pupilage of five years with Sir William Copland.

In 1900-1901 Mr. Macreath was contractor's engineer during construction on the Muirkirk section of the Caledonian Railway, and was subsequently assistant resident engineer of construction and later resident engineer on the Strathaven section of the same railway, remaining in that position until October 1905, when he went to Ashanti, West Africa, to carry out a branch railway for Attasi Mines Limited. Following this Mr. Macreath came to Canada, and was connected for a time with the Canadian Pacific Railway Company on the construction of the Westmount low level yard and relative approaches to the main line. Mr. Macreath then went to the Sault and was employed by the Algoma Central Railway. From 1915 to 1919 he was overseas with the 37th Battalion, having the rank of lieutenant. At the time of his death he was connected with the Department of Public Works, at Sault Ste. Marie, having held that appointment for a number of years.

Mr. Macreath was interested in public affairs, and held the post of sheriff, to which he was appointed on May 29th, 1920.

He joined The Institute (then the Canadian Society of Civil Engineers) on December 12th, 1907, as a Student, and became an Associate Member on April 9th, 1910.

PERSONALS

G. K. Waterhouse, A.M.E.I.C., has recently become identified with Toronto Iron Works as local representative at Montreal.

D. G. Elliot, Jr.E.I.C., is now on the staff of the Anglo-Newfoundland Development Company Ltd., at Grand Falls, Newfoundland.

Jas. W. Houlden, Jr.E.I.C., who was formerly with the Canadian Ingersoll-Rand Company Ltd., at Sherbrooke, Que., has joined the staff of Canadian Industries Limited, and is located at Brownsburg, Que.

Boyd Candlish, A.M.E.I.C., formerly chief engineer of the gear division of the Palmer Bee Company, Detroit, has resigned his position with that firm, and will carry on his studies of gearing as an individual venture.

C. H. Fullerton, A.M.E.I.C., has become Surveyor-General of the Province of Ontario. Mr. Fullerton has held the office of Deputy Minister of Northern Development for some years, and during the reorganization of the department he was appointed head of the Settlers' Loan Board.

J. Lyle McDougall, Jr.E.I.C., is now with Somerville Paper Boxes Limited, at London, Ont. Mr. McDougall was formerly on the staff of Price Brothers and Company Ltd., at Kenogami, Que.

J. M. Robertson, M.E.I.C., consulting engineer, Montreal, has been nominated by the Montreal Board of Trade as its representative on the commission to study the problem of a purification plant for the city. Among the questions with which the commission proposes to deal is the basic one as to whether immediate action is necessary in connection with the sewage disposal problem.

J. Antonisen, M.E.I.C., who recently retired from the office of city engineer of Port Arthur, Ont., was tendered a complimentary dinner by the Lakehead Branch of The Institute. Mr. Antonisen is chairman of the Branch.

E. M. Proctor, M.E.I.C., president of the firm of James, Proctor and Redfern, consulting engineers, Toronto, has been elected a director of the Guaranty Trust Company of Canada, of Windsor and Toronto.

A. Cousineau, A.M.E.I.C., superintendent engineer, Division of Sanitation, Health Department, City of Montreal, is the first recipient of the award which the City Improvement League of Montreal has decided to make annually for distinguished public service, to go to the educator, social service worker, civic official or other public spirited citizen who in the opinion of the judges has rendered the most outstanding service in helping to improve the city. Mr. Cousineau is a graduate of Mount St. Louis College, Ecole Polytechnique, Massachusetts Institute of Technology, and Harvard University. Prior to his appointment to the city health department he was attached to the scientific division of the topographical surveys of the Federal government. Mr. Cousineau has been particularly interested in all matters pertaining to sanitation for the past twenty-one years and was one of the collaborators of Dr. S. Boucher, medical officer of health, under whom he has prepared and enforced several by-laws.

Professor R. W. Angus, M.E.I.C., Head of the Department of Mechanical Engineering, University of Toronto, Toronto, Ontario, sailed from New York on May 15th, 1935, on the *President Roosevelt* for Hamburg. Professor Angus will visit water power plants in Sweden and Germany, and then spend some time in England. He will return to Canada about the middle of August.

C. D. Evans, Jr.E.I.C., has been appointed sales manager of the Canadian Gypsum Company Limited for Quebec and the Maritime Provinces, and will be located in Montreal. Mr. Evans has been with this company for the past five years, in Montreal and Halifax, N.S., having previously been estimator and engineer for Gypsum Lime and Alabastine Canada Ltd. at Toronto. He was at one time with the Fraser Brace Engineering Company. Mr. Evans graduated from McGill University in 1924.

Harry H. Bell, A.M.E.I.C., who was formerly connected with the Calgary Power Company, Calgary, Alta., has joined the staff of the Montreal Engineering Company, Montreal. Mr. Bell graduated from the Nova Scotia Technical College in 1929 with the degree of B.Sc., and secured the degree of S.M. in business and engineering administration from the Massachusetts Institute of Technology in 1933. He takes an active interest in Institute affairs, and has been serving as Secretary-Treasurer of the Calgary Branch.

L. M. Jones, M.E.I.C., was recently appointed vice-president and general manager of the Warren Bituminous Paving Company Ltd. Mr. Jones, who was born in Wales, came to this country in 1896, and three years later entered the service of the Canadian Pacific Railway Company as a draughtsman at Winnipeg, subsequently becoming instrumentman in charge of a survey party. In 1903 he became connected with the Winnipeg Electric Railway Company and for three years had charge of laying out track, construction car barns and sub-stations, including the large Portage Avenue sub-station. In 1906 Mr. Jones was appointed assistant city engineer of Port Arthur, Ont. remaining in that position until 1909 when he joined the staff of Smith, Kerry and Chace, Toronto, being engaged on hydro-electric power plant design. In 1910 he returned to Port Arthur as assistant city engineer, and in 1911 was appointed city engineer. In 1920 Mr. Jones resigned in order to become general superintendent at Toronto for the Warren Bituminous Paving Company Ltd., and in 1923 he was elected to the board of directors of that company and made chief engineer and secretary, which position he has held up to the present time. Mr. Jones is a member of the American Society of Civil Engineers and also of the Association of Professional Engineers of Ontario.

Results of May Examinations of the Institute

The report of the Board of Examiners, presented at the meeting of Council held on May 21st, 1935, certified that the following candidates, having passed the examinations of The Institute, have satisfied the examiners as regards their educational qualifications for the class of membership named:

Schedule C—For admission to Associate Membership:

William Herbison,	Lachine, Que.
Cecil George Kemp,	Montreal, Que.

Schedule B—For admission as Junior:

Eric Grant,	Montreal, Que.

Report of Committee on Consolidation

The Committee held its sixth meeting at The Engineering Institute Headquarters on Friday, May 10th, 1935, at 8 p.m., and continued at the University Club on Saturday, May 11th, at 1.30 p.m. The reports from the various organizations, Branches and Associations in the different provinces were reviewed. The reports and resolutions received indicate good progress is being made in the organization and consideration of the question of Consolidation.

The Committee approved a letter and questionnaire covering certain fundamental points relative to Consolidation, and authorized that it be issued to the Secretaries or Corresponding Members of Branches, and the Registrars of Provincial Associations and the Secretary of the Committee of Eight. This letter and questionnaire is published herewith and reprints may be made available to Branches or Associations desiring to use the same to obtain the individual opinions of their members. This Committee urges Branches and Associations to take the necessary steps to insure replies to this questionnaire being returned on or before June 30th.

The seventh meeting of the Committee was held at The Engineering Institute on Tuesday, May 20th, 1935, at 6 p.m., at which time it was reported that the letter and questionnaire had been issued, together with statistics on the membership of The Institute Branches and the Provincial Associations, the progress report and questionnaire of the Saskatchewan Co-ordinating Committee, and the progress report of this Committee.

The Committee received the resolution of the Executive of the Saint John Branch appointing Mr. G. G. Murdoch and Mr. A. A. Turnbull as a special committee for the consideration of Consolidation, and to co-operate with a similar committee from the Moncton Branch and the Professional Association of New Brunswick.

It was reported that a meeting of a special committee of the Ontario Professional Association, under the chairmanship of Mr. J. Clark Keith, met in Toronto on May 17th, to consider the questionnaire and other phases of Consolidation. Mr. H. A. Lumsden, M.E.I.C., has been appointed by the Executive of the Hamilton Branch to represent the Branch on a Provincial Consolidation Committee. The Toronto Branch Executive has appointed the following special committee on Consolidation,—C. E. Sisson, M.E.I.C., Chairman; O. Holden, A.M.E.I.C., and W. W. Bonn, M.E.I.C., Mr. Sisson was also appointed to represent the Branch on the Joint Provincial Committee on Consolidation.

The Victoria Branch held a meeting on May 7th, to review all reports and correspondence relative to Consolidation, and reported that they were now awaiting action by the Vancouver Branch on their suggestion of a joint committee of the two Branches in British Columbia to consider this question.

Under date of May 20th, the Saskatchewan Branch of the E.I.C. and the Association of Professional Engineers of the Province of Saskatchewan, through their joint committee, returned the questionnaire with all five questions answered in the affirmative.

The Saguenay Branch of The Institute have appointed Messrs. H. R. Wake, A.M.E.I.C., J. Shanly, A.M.E.I.C., G. F. Layne, A.M.E.I.C., and H. B. Pelletier, A.M.E.I.C., as a special committee of the Branch to study and submit a recommendation on Consolidation.

QUESTIONNAIRE OF THE COMMITTEE ON CONSOLIDATION

The Committee appointed by the Annual Meeting of The Engineering Institute of Canada at Toronto on February 7th, to "Develop the Possibilities of the Consolidation of the Engineering Profession," has arrived at a point in its deliberations where it becomes necessary to obtain an expression of opinion from the various interested organizations throughout Canada on certain questions fundamental to Consolidation.

The Committee has received many resolutions relative to Consolidation and to the proper procedure leading to its realization, and to many of the details of its organization. In order that all opinions and suggestions may be expressed in a uniform and comparable sense, it has been decided to issue this questionnaire.

Though your Branch or Association may have already expressed itself on the broad principle of Consolidation, might we ask you to again indicate your attitude.

1. Are you in favour of the broad principle of Consolidation of the Engineering Profession in Canada?

YES ☐ NO ☐

Consideration of the possibilities of the Consolidation of our profession suggests three main features:—

1. Membership.
2. Fees.
3. Organization.

Under the heading of "Membership" it is only necessary at this time to consider the principal classification of corporate or practising member, and to obtain an expression of opinion as to those to be included therein. All secondary classifications can be discussed at a later date with other details.

It would appear that engineers who are members of the Provincial Professional Associations and/or corporate members of The Engineering Institute of Canada, form the essential units of Consolidation. The question is to determine the most satisfactory and acceptable method of harmonizing the interests of these individuals and organizations so as to produce the most practical and effective and united professional body.

It should be borne in mind that the existing Professional Associations are legally constituted and that it is essential that the rights and privileges conferred by these Provincial enactments, which must be maintained under the British North American Act, be conserved and developed in the interests of the profession.

If this principle is accepted, a definite line of procedure is indicated. The first question concerning membership would therefore appear to be:—

2. In your opinion, should the corporate membership of the Provincial Professional Associations and of the National organization be identical?

YES ☐ NO ☐

In view of the fact that The Engineering Institute of Canada has for many years represented the engineers of this country both at home and abroad, and by its activities, its traditions and its many connections is most admirably suited to such a function:—

3. Are you in favour of The Engineering Institute of Canada being accepted as the National body of the consolidated engineering profession in Canada?

YES ☐ NO ☐

The next feature of Consolidation to come up for consideration is that of Fees. At present the fees of the corporate members of The Institute vary from $8.00 to $15.00 per annum net, while the membership fees of the Provincial Associations vary from $2.50 to $10.00 net per annum in the different provinces. On the basis of the membership statistics of The Engineering Institute and of the various Provincial Professional Associations for the year 1934, Consolidation would provide a corporate membership in the National body of some 5,000 engineers.

In view of the fact that the general expenses of the Provincial Associations vary in the different provinces, while the activities of the National organization call for a uniform per capita contribution from each member, it would appear that the total fee payable by a member would be a summation of a variable Provincial fee plus a fixed amount required for the maintenance and promotion of the National organization.

4. Under Consolidation, would you be willing to pay a single annual membership fee which would include a uniform subscription from each member of the profession throughout Canada to the National organization?

YES ☐ NO ☐

We have next to consider the organization of the profession in a Provincial and in a National sense. As the legal constituencies must be recognized, it is evident that the detailed administration of the profession in respect to admission, collection of dues, discipline, legal action, etc., should be Provincial matters, carried out by the Provincial organization. Such an arrangement tends to directness and promptness in the management of the detailed affairs of the profession.

The National organization should carry on all the more general activities of the profession, such as maintaining the publications, promoting uniformity in ethical procedure and in the legal recognition of the profession throughout Canada, and providing a contact with other national organizations and a unity of expression on national affairs and in the interests of the profession as a whole.

5. In view of the fact that discipline and legal action are at present a function of the Provincial Associations, are you in favour of the administration of admission to membership and collection of fees also being made the responsibility of the Provincial organizations?

YES ☐ NO ☐

This questionnaire is not a ballot, but is intended to provide information on certain aspects of Consolidation to assist the Committee in its deliberations. The questions are drawn so as to be answered in the simple affirmative by marking an X in the square opposite "Yes" and similarly for a negative. If for any reason it is necessary for you to answer in the negative, please outline your alternative suggestion covering the point.

We would ask that your Branch or Association consider these questions at such time as to give this Committee your replies on or before June 30th, 1935. Your cooperation in this matter would be very greatly appreciated.

Signed..

Dated........ ....
(Institute Branch)

Elections and Transfers

At the meeting of Council held on May 21st, 1935, the following elections and transfers were effected:—

Members

BOWEN, Henry Blane, chief of motive power and rolling stock, C.P.R., Montreal, Que.

DEMIFFONIS, Louis Fernand Henri, (Univ. of Paris), acting chief engr., Dept. of Marine, Ottawa, Ont.

FYSHE, Thomas Maxwell, B.Sc., (McGill Univ.), private practice, investigations and reports, 388 St. James St. West, Montreal, Que.

GRATTON, Alphonse, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), district engr., Dept. of Roads, Prov. of Quebec, Quebec, Que.

NEWMAN, William Arthur, B.Sc., (Queen's Univ.), chief mech'l. engr., C.P.R., Montreal, Que.

Associate Members

BUCK, Leslie Gordon, B.A.Sc., (Univ. of Toronto), divn. plant engr., Montreal Divn., Bell Telephone Company of Canada, Montreal, Que.

*HERBISON, William, (Montreal Tech. Inst.), dftsman., Dominion Bridge Company, Ltd., Lachine, Que.

*KEMP, Cecil George, (Sydney Tech. Coll., N.S.W.), constrn. supt. and engr., Consumers Glass Co. Ltd., Montreal, Que.

MACGILLIVRAY, Malcolm Stuart, B.Sc., (Queen's Univ.), elect'l. and mech'l. engr., T. Pringle & Son Ltd., Montreal, Que.

SPENCER, Henry Cyril, (Montreal Tech. Inst.), i/c design dept., screwmach. tools and equipment, Northern Electric Company Ltd., Montreal, Que.

Juniors

*GRANT, Eric, (Montreal Tech. Inst.), field engr., Montreal Light, Heat and Power Cons., Montreal, Que.

HERSHFIELD, Charles, B.Sc., (Univ. of Man.), Room 310, 68 King St. East, Toronto, Ont.

LYMAN, Charles Philip, B.Eng., (McGill Univ.), 4155 Cote des Neiges Road, Montreal, Que.

Affiliate

ALEXANDER, Stanley George, (Chicago Tech. School), chief operating engr. of steam power plants, Canadian General Electric Co. Ltd., Peterborough, Ont.

Transferred from the class of Associate Member to that of Member

ARCHIBALD, Samuel Wallace, B.A.Sc., (Univ. of Toronto), consltg. engr. and O.L.S., London, Ont.

BEACH, Floyd Kellogg, engr., Petroleum and Natural Gas Divn., Dept. of Lands and Mines of Alberta, Edmonton, Alta.

CORMIER, Ernest, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), architect and consltg. engr., Montreal, Que.

FARRELL, James Wardrope Dick, B.Sc., (Queen's Univ.), supt. of waterworks, Regina, Sask.

LAFLECHE, Alphonse, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), asst. chief engr., River St. Lawrence Ship Channel, Dept. of Marine, Ottawa, Ont.

MOTT, Harold Edgar, B.Sc., (McGill Univ.), President and Gen. Mgr., H. E. Mott Co. Ltd., Brantford, Ont.

YOUNG, Stewart, B.A.Sc., (Univ. of Toronto), director of town planning, Prov. of Sask., Regina, Sask.

Transferred from the class of Junior to that of Associate Member

CHANDLER, Edward Sayre, B.Sc., (N.S. Tech. Coll.), prov. elect'l. inspr., Charlottetown, P.E.I.

Transferred from the class of Student to that of Associate Member

PETURSSON, Franklin, B.Sc., (Univ. of Man.), location engr., Dept. of Northern Development, Kenora, Ont.

Transferred from the class of Affiliate to that of Associate Member

SAMUEL, Myron, Diploma, (Engrg. College, Danzig), proprietor, Empire Engineering Company, Toronto, Ont.

Transferred from the class of Student to that of Junior

SMITH, Carl Clifford, B.Sc., (Queen's Univ.), induction motor engr., Canadian Westinghouse Co. Ltd., Hamilton, Ont.

SMITH, Walter Alexander, B.Sc., (Univ. of Alta.), Dominion Bridge Co. Ltd., Calgary, Alta.

*Has passed Institute's examinations.

Students Admitted

BENSON, Willard McLean, B.Sc., (Univ. of N.B.), Fredericton, N.B.

BRANCHAUD, Henri, (Ecole Polytechnique, Montreal), 636 Dunlop Ave., Outremont, Que.

BRANNEN, Edwin Ralph, B.Sc., (Univ. of N.B.), North Devon, N.B.

CLARKE, Ross Eugene, B.Sc., (Queen's Univ.), R.R. No. 3, Gananoque, Ont.

COOMBES, David Eaton, B.Sc., (Univ. of N.B.), North Devon, N.B.

DARWIN, Bascom Herman, B.Sc., (Queen's Univ.), 132 Earl St., Kingston, Ont.

GREGOIRE, Armand E., B.A.Sc., C.E., (Ecole Polytechnique, Montreal), 6349 St. Denis St., Montreal, Que.

HORNFELT, Harvey Andrew, (Univ. of Toronto), 45 Sussex Ave., Toronto, Ont.

HUGGARD, John Harold, B.Sc., (Univ. of N.B.), Norton, N.B.

KAZAKOFF, John, B.Eng., (McGill Univ.), P.O. Box 252, Kamsack, Sask.

LEAHEY, James C. P., B. Eng., (McGill Univ.), c/o C. A. P. Leahey, Esq., Bank of Montreal, Ottawa, Ont.

LILLEY, Ledford George, B.Sc., (Univ. of N.B.), 57 Havelock St., Saint John, N.B.

MEUSER, Henry Lloyd, B.Sc., (Queen's Univ.), (Grad., R.M.C.), 132 Earl St., Kingston, Ont.

MILLER, Alex. Matthew, B.Sc., (N.S. Tech. Coll.), New Waterford, N.S.

MUSSEN, Guy Aubrey, B.Eng., (McGill Univ.), 2076 Sherbrooke St. West, Montreal, Que.

PEQUEGNAT, Jared Marc, B.Sc., (Queen's Univ.), 9 Samuel St., Kitchener, Ont.

PRESTON, William Walford, B.Sc., (Queen's Univ.), 25 Walnut St. North, Hamilton, Ont.

PURVES, William Franklin, B.Eng., (McGill Univ.), 3508 Durocher St., Montreal, Que.

REYNOLDS, George Kenly, B.Eng., (McGill Univ.), 3737 De l'Oratorie Ave., Montreal, Que.

ROSS, Donald, (Univ. of N.B.), 126 Douglas Ave., Saint John, N.B.

ROWELL, Lorne Archibald, B.Eng., (McGill Univ.), 3420 Hutchison St., Montreal, Que.

ST-JACQUES, Gustave F., (Ecole Polytechnique, Montreal), 425 Blvd. St. Joseph West, Montreal, Que.

SADLER, Robert Francis, (Univ. of N.B.), Chatham, N.B.

SCHOFIELD, Robert John Graham, B.Eng., (McGill Univ.), 340 Ballantyne Ave. No., Montreal West, Que.

SUTHERLAND, James Gordon, B.Sc., (N.S. Tech. Coll.), St. Peter's Bay, P.E.I.

TWEEDDALE, Reginald Estey, B.Sc., (Univ. of N.B.), Arthurette, N.B.

WISDOM, Charles Stuart Cotton, (Grad. R.M.C.), (McGill Univ.), 47 Hemlock Ave., Shawinigan Falls, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Canadian Institute of Mining and Metallurgy: Transactions, 1934.
University of Toronto, Engineering Society:
Transactions and Year Book, 1935.

Reports, etc.

Armour Institute of Technology: Bulletin, May 1935.
Engineers' Council for Professional Development:
Second Annual Report, 1934.
Quebec Harbour Commissioners: Annual report 1934.
American Society of Mechanical Engineers:
Papers and Programme, aeronautic and hydraulic divisions: Summer meeting June 1934.
New York State Planning Board: Summary Report of Progress 1935.
Société des Ingénieurs Civils de France: Annuaire de 1935.
American Institute of Mining and Metallurgical Engineers:
Directory 1935.
Port of Vancouver, B.C.: Annual Report 1934.
Lethbridge Northern Irrigation District:
14th Annual Report and Financial Statement 1934.
Association of Consulting Engineers Inc.:
Notes upon the Professional Duties of Consulting Engineers, their Relationship with Clients and General Information as to Fees.
National University of Ireland: Calendar for the year 1934.

Technical Books, etc., received

Highways and their Maintenance, by W. J. Hadfield. (*The Contractors' Record Limited.*)
Canadian Trade Index, 1935. (*Canadian Manufacturers' Association.*)
Water Works Practice, a manual issued by the American Water Works Association. (*The Williams and Wilkins Co., Baltimore.*)

BOOK REVIEWS

Electric Wiring

By W. S. Ibbetson, E. and F. N. Spon, London, 4th edition, 1935. 4¾ by 7½ inches, 253 pages, diagrams, etc. 6/-. Cloth.
Reviewed by W. P. Dobson, M.E.I.C.*

That this book has, in England, served a useful purpose is indicated by the fact that it has already run through three editions there. On this side of the Atlantic one may cull from it, here and there, items of information which are new and interesting, but the book is necessarily of less practical value to men living and working in Canada. The reason for this is of course that Canadian electric wiring practice, following closely as it does that of the United States, differs widely from that of England and other parts of the Empire, both as to types of equipment used and to the methods of installation in vogue.

The book is clearly written in simple style and has many good wiring and other diagrams; it is manifestly intended for the practical man and the calculations given are by no means abstruse.

The various chapters cover such subjects as Ohm's law applied to a.c. and d.c. circuits; distribution; wiring systems; joints, soldering, etc.; testing; illumination; motors, a.c. and d.c.; all treated from the standpoint of installation work.

Chief Testing Engineer, Hydro-Electric Power Commission of Ontario, Toronto.

Mechanics and Applied Heat with Electrotechnics

By S. H. Moorfield and H. H. Winstanley, Longmans, Green and Company, Toronto, Ont., 1935. 4¾ by 7½ inches, 392 pages, Cloth. $2.00.
Reviewed by Lieut.-Colonel L. W. Gill, M.E.I.C.*

This book, as stated in the preface, has been written with the object of producing in one volume a course in engineering science which will prepare a student for his entry upon the final year of the Ordinary National Certificate Course (England). It covers a very broad field, 143 pages being devoted to mechanics, 160 to thermodynamics, 15 to hydraulics and 63 to electrotechnics. For the special purpose specified by the authors this book should serve the student effectively. Notwithstanding this, the reviewer is inclined to think that there is some room for improvement. The principles of mechanics have been presented clearly and in logical sequence, but one wonders why, in the section on thermodynamics, the chapter on gases should be placed before the chapters on steam, production of power and measurement of power rather than after. Apart from this the presentation is clear and concise.

The 16 pages devoted to hydraulics cover such a small part of the field that one is inclined to question the value of such a presentation in a text of this kind.

The section on electrotechnics is well written and well illustrated. To the electrical engineer, however, the treatment of induced electromotive force is very inadequate. Its relative importance entitles it to more than 2 pages out of 63.

In all sections of the book the principles presented are well illustrated by figures and typical applications. Many suitable problems are included in each section. With a very few exceptions technical terms are accurately defined and accurately used.

Principal, Hamilton Technical Institute, Hamilton, Ont.

Mechanics

A Text-Book for Engineering Students

By Frank Gardner, Oxford University Press, London, 1934. 5 by 7½ inches. Diagrams, 254 pages. Cloth. $2.25.
Reviewed by Mr. Ian McLeish*

This text-book, as the title implies, is intended primarily for engineering students, but it would serve equally well for students in technical schools, since calculus or complicated mathematical expressions are conspicuous by their absence. The author's method of approach is somewhat different from that usually employed in text-books on mechanics, for most writers start with a consideration of the law of moments and polygon of forces. Mr. Gardner begins with the principle of the ideal machine, and explains, for instance, how a small force acting through a long distance can be made to balance a large force moving through a shorter distance. This idea leads to the study of work and power. The use of vectors is introduced and then the effects of friction are considered. Dimensional methods are used throughout the book. Chapters follow on the conditions of equilibrium, mechanisms and velocity diagrams, and structures and stress diagrams.

The second section of the book deals with strength of materials, and the concluding chapters are devoted to elementary dynamics.

Throughout the book care is taken to present clearly the fundamental ideas on such points as momentum and acceleration and dimensional arithmetic is not forgotten. It is somewhat difficult to understand why English text-books of this kind stil use in their examples cwts. and tons instead of expressing weights in pounds.

The book is well illustrated with clear and simple diagrams, a feature which will be found a great help in driving home the various principles enunciated. There are plenty of problems of a practical nature which give ample scope for the drill which is so necessary for the proper comprehension of all mathematical subjects. Answers are given as a check on the solution of the various problems. The book is suited for a first year course in engineering and its methods of treatment should be of interest to all connected with the teaching of mechanics, strength of materials and hydraulics.

Assistant Principal, Montreal Technical School, Montreal.

Canadian Trade Index—1935

The eleventh annual issue of the Canadian Trade Index which has been received contains an alphabetical directory of Canadian manufacturers with addresses, branches export representation, trade marks and brands; a directory of Canadian manufacturers classified according to articles made; a directory of exporters of agricultural produce and an export section which gives details of government services, export procedure, costs and financing statistics of Canadian trade and production. This new edition, which has over 800 pages, includes the names of some three hundred new manufacturers.

The publication of this book, containing as it does the names of members and non-members alike, is one of the many services rendered by the Canadian Manufacturers' Association to the manufacturing community and the business public at large. The continuance of old and new features will prove most valuable in keeping Canadian users fully informed respecting goods produced in Canada and in putting importers in other countries expeditiously and efficiently in touch with Canadian sources of supply.

World Survey

Published under the Auspices of the World Power Conference by Lund, Humphries and Company Limited, 12 Bedford Square, London, W.C.1, England. Monthly. Single copies 5/-, 12 issues £2-0-0.

This monthly periodical is being issued under the auspices of the World Power Conference, for the exchange of economic and technical information. Its contents will include authoritative articles on industry and economic thought, largely from the point of view of the analysis of economic forces and their effect on the development of international trade and industry. It will also contain statistical information, in the form of world economic indices, and an international power and fuel bibliography of a selective and authoritative nature, giving abstracts of the more important items published in current literature dealing with power and fuel. The first number gives promise of a valuable addition to our available sources of information on these topics.

BULLETINS

Pipe Threading.—An 8-page booklet has been received from The Steel Company of Canada Ltd., Montreal, containing practical tips on pipe threading.

Steel Sheet Piling.—The Canadian Sheet Piling Co. Ltd., Montreal, have issued a 4-page leaflet explaining the application of Larssen sheet piling to the Lakeshore retaining wall of the Victoria Park filtration plant, Toronto.

Concrete Machinery.—A 20-page bulletin received from the London Concrete Machinery Company Ltd., London, Ont., contains particulars of various types of mixers, hoists, engines, pumps, barrows, etc., for the handling of concrete.

Induction Motors.—A 4-page pamphlet issued by the English Electric Company of Canada Ltd., St. Catharines, Ont., gives information regarding the new completely protected induction motor.

Caterpillar Tractors.—The Caterpillar Tractor Company, Peoria, Ill., have issued a 24-page booklet illustrating the various applications of tractors to ploughing.

Wood Preservation.—A 10-page publication received from the Tennessee Eastman Corporation, Kingsport, Tenn., describes the preservation of wood with NO-D-K, a form of creosote oil.

The Panama Canal

Opened to traffic on August 15th, 1914, the Panama canal last year completed twenty years of successful operation, during which it has been navigated by 77,493 vessels having a total net tonnage of 366,761,032 and carrying 363,766,614 tons of cargo. The annual report of the Governor of the Canal for the year ending June 30th, 1934, shows that after two years of traffic decline the returns for the twelve months under review show welcome increases in the number of ships passing through the canal, the total tonnage of the vessels, the tolls collected and the tonnage of the cargo carried. The ocean-going vessels which utilized the canal in 1933-34 totalled 6,036 making together 28,566,595 net tons against 4,939 vessels and 22,821,876 tons in 1932-33.

The cargo conveyed through the canal in 1933-34 amounted to 24,718,651 tons and was 36 per cent higher than that passing through in the previous twelve months. Traffic in both directions contributed nearly equally to the increase in cargo tonnage, the rise in shipments from the Atlantic to the Pacific being 36.7 per cent, and that from the Pacific to the Atlantic 35.7 per cent.—*Engineering.*

CORRESPONDENCE

THE EDITOR,
THE ENGINEERING JOURNAL,
Montreal, Canada.

Woodbridge, N.J.
April 26th, 1935.

DEAR SIR:—

The writer of this letter has been absent from Canada for some years, and consequently is not so familiar with the problem of engineers' organizations as most of the resident members. I have received a circular containing a resumé of this situation by our past-president, Mr. F. P. Shearwood, M.E.I.C.

Mr. Shearwood refers to the difficulty of defining the status of many of our members who are designated as employees. This is a difficulty which The Institute must resign itself to and I fear will aggravate itself with the further development of our industry. Personally I would like to urge our president to consider the timeliness of formulating a policy along this very important phase of The Institute's relationship, i.e. to the engineer who is an employee. He probably constitutes a majority of our membership.

In many ways Canada is similarly constituted in its social structure to the United States. It must be recognized that while we may have a much larger diffusion of wealth throughout our society than most radical politicians are ready to admit, we are nevertheless subject to an increasingly greater concentration of control. This implies larger units of management, more employees and more stockholders but fewer managers and independent professional specialists. These tendencies undoubtedly are at work in the Dominion.

To the writer, the idea of provincial or state engineers' associations composed of land surveyors, town engineers and construction engineers, to the exclusion of industrial engineers is an anachronism. It is even a moot question as to whether the medical profession can long defend itself against some form of socialization.

I think our Institute should recognize these tendencies and influence their course for the benefit of the rank and file of our members. Protection of the public is a favourite argument with those who would restrict the practice of the profession.

Certainly adherence to narrow legal standards would restrict many good engineers of sound scientific training and experience from ever entering private practice. In a complex industrial society many problems of design exist which are utterly beyond the ability of the general practitioner type of engineer. Were it not for the creative ability of our employee engineers our modern industry would hardly advance. I can readily conceive of regulations obtaining legal sanctions which would exclude even a Steinmetz from private practice.

The importance of the consulting engineer is rapidly declining. He has little or nothing to offer to many industries who have as a matter of fact developed their own consultants. Many of our engineers while in the service of employers have created their own status and are in fact just as truly consultants as the private practitioner.

Personally I believe more recognition to general scientific training is desirable, especially in the case of the engineer who has a post graduate degree. A publicity campaign seeking to increase the compensation of the employee engineer might be of advantage. This would discourage overcrowding during periods of inadequate compensation, while a knowledge of salaries paid in different districts might encourage engineers seeking employment to demand more reasonable returns for their labour.

Our Journal appeals to me because of the variety of subjects dealt with in the published papers. It loses greatly in value however, because of the omission of the Engineering Index. I for one, hope this feature will be restored.

Our Institute should continue to be a clearing house for sound scientific knowledge. It should also be in a position to attest the ability of its members, in other words membership in The Institute should of itself be evidence of the engineer's competence.

Very truly yours,
(Signed) W. K. THOMPSON, A.M.E.I.C.

Rapid Development of God's Lake Gold Mine

God's Lake mine is described by W. F. Baker in a paper entitled "Geology of God's Lake Gold Mine Limited" in the May Bulletin of the Canadian Institute of Mining and Metallurgy. Discovered in the summer of 1932, the deposits were diamond-drilled in 1933, indicating ore of fairly high grade in payable quantity. During the winter of 1933-34 a mining plant and supplies totalling 1,260 tons were hauled from the railway, and levels were opened at 150 and 275 feet depth. As this confirmed the presence of sufficient ore for two year's supply for a 150-ton mill, the machinery for this was hauled in during the past winter and will be ready for operation by the early autumn. A water-power site nearby is also being developed to provide ample power. Thus in three years from the time of its discovery a profitable operation will have been established in this remote locality.

The distance by winter road from the Hudson Bay Railway is 130 miles; but so cheaply can supplies be taken in over the level winter road by tractor train, and so little is required per ton of ore treated (20 pounds) that the charge for this freighting per ton of ore treated is only 30 cents. This 30 cents thus measures the additional cost of operating at a distance of 130 miles from the railway, compared with operating at the "jumping-off" point.

Electric Furnace Foundry of the Ford Motor Company of Canada Ltd.

The $425,000 electric furnace foundry of the Ford Motor Company of Canada, Limited, at East Windsor, Ont., went into production toward the end of March. It was formally opened March 29th when the Border Cities Branch of The Engineering Institute of Canada held its monthly meeting at the Ford plant. The engineers were guests of the company at dinner in the home office restaurant, and John Coulter, A.M.E.I.C., president of The Institute Branch, acted as chairman. Wallace R. Campbell, president of the Ford company, welcomed the nearly one hundred guests, and John S. Beaumont, chief chemist, gave a paper on the chemistry of the steel used and the physical characteristics of the cast alloy steel crankshaft produced in the new unit.

The new foundry is a smaller counterpart of the huge crankshaft foundry at the Rouge plant of the Ford Motor Company, which was the first in the world to make cast steel crankshafts in volume for modern motor car engines.

It is now commonplace Ford practice to cast a steel crankshaft for its V-8 engine which is superior in service and longer lived than the forged crankshaft formerly used. Whereas in tests the forged shaft shows measurable wear after 10,000 miles of car operation, the cast shaft shows none (less than 2/10,000 inch).

Aside from an improvement in the product from the standpoint of serviceability, there are appreciable advantages in manufacturing a cast as compared with a forged crankshaft. It is about 10 pounds lighter than the forged shaft because of the use of cored crankpin journals and the reduction in weight of the corresponding counterbalances. The forged shaft weighed approximately 90 pounds in the rough and 66 pounds when finished, 24 pounds being removed in the machining process. Only nine pounds of metal is taken off the cast shaft in machining, and the machining operations now number 50 as against 62 on the forged shaft. A considerable saving in manufacturing cost is expected to be realized.

Metal for the castings is prepared in a five-ton electric furnace, the charge consisting of 40 per cent steel scrap and the balance pig iron, back stock and alloys. All the scrap comes from the company's own production in East Windsor, and can therefore be carefully controlled as to analysis.

The foundry is successfully handling five heats a day, which permits of a maximum production of 475 crankshafts, enough to take care of production at the maximum of about 460 engines per day, the rate at which the East Windsor plant has been currently operating.

After the steel is poured, the moulds move for some distance on an overhead conveyor from which are suspended special carriers. When the moulds have had time to cool slowly, the sand is knocked off and falls into a pit, from which it begins its journey by conveyor to the dump bins. New sand is used for all cores, no reconditioning being possible for this casting. The castings themselves remain on the conveyor and are further cooled, after which the "gates" of the castings are removed. The individual cast shafts are hung on conveyors for cleaning, grinding and inspection prior to heat treatment. The entire casting of four crankshafts, together with gates and risers, weighs about 420 pounds.

Fig. 1—Charging the Five-Ton Electric Furnace.

The shafts are now passed through a double heat treatment in one 62-foot continuous furnace. After the heat treatment the shafts are loaded on the return half of the conveyor, and then are transferred to the first operation of a drop test to make sure the shaft is perfect before commencing to machine. Brinell hardness is taken and machine shop operations commence.

Cores are made on a rotary core-table of special design. This is a Ford development, built especially for their requirements.

Operators transfer the cores from the core-table to a vertical core oven of the continuous type, where they are baked under controlled conditions of time and temperature. Core plates are hung on a conveyor which takes them through a washing machine and back to the core-making machine.

Fig. 2—Pouring from the Electric Furnace.

After being baked, cores are placed on a flat rotary type carrier on a chain conveyor, where they are faced and washed. They are then inspected, gauged and inserts are placed in position.

After a further inspection cores are placed on racks on a continuous storage conveyor running along the core assembly line. This conveyor eliminates the necessity of having a storage room for cores with the consequent handling expense. It enables operatives along the assembly line to have available constantly at their elbows a correct supply of the various cores going into the build-up. The build-up is held to an overall accuracy of 30/1,000 inch.

By carefully watching the heat treatment factors, the shafts will remain straight and the Brinell hardness and physical properties will be within the proper limits. The allowable limits on physical properties are:—

Elastic Limit	Ultimate	Twist at Elastic Limit	Twist at Ultimate	Brinell
Maximum 88,000	128,000	9°	16°	255
Minimum 96,000	130,000	6°	25°	321

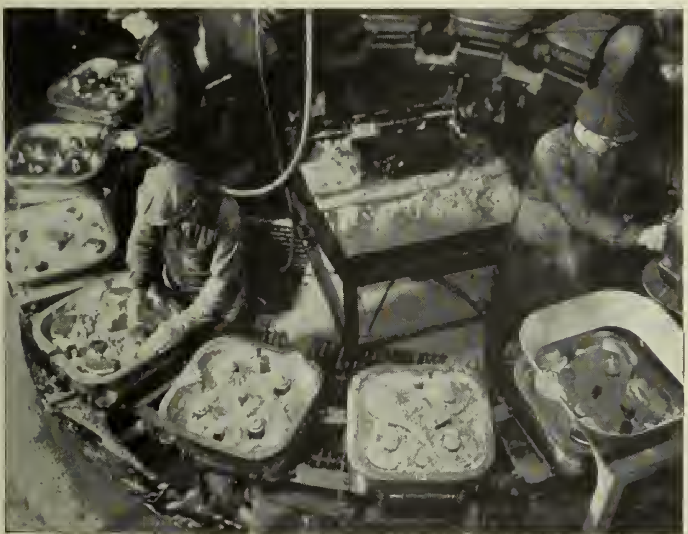


Fig. 3—Rotary Core-Making Machine.

Impact: Drop of 50 pounds 40 inches to flange of centre main bearing —2,000 inch-pounds.

Test Bar:	Elastic Limit	Tensile Strength	Elongation	Reduction Area	Brinell
Maximum	91,000	108,000	1.5	2.0	255
Minimum	93,500	107,000	2.0	2.5	269

Transverse:	Breaking	Deflection	Brinell
Maximum	9,565	.420	255
Minimum	9,330	.430	269

The composition of the cast steel is as follows:—

Carbon	1.35/1.60
Manganese	0.50/0.60
Silicon	0.85/1.10
Chromium	0.40/0.50
Copper	1.50/2.00
Phosphorus	0.10 maximum
Sulphur	0.06 maximum

Fig. 4—Assemblies of Crankshafts Before Separation.

Because of the difficulty in machining this unusual material, which can be classified as "high carbon, high copper, chrome-silicon cast steel," special hammered high-speed steels are employed. Work speeds of machine tools have been cut down, but feeds have generally remained the same in machining the cast shaft as compared with the forged product. The cutting tool is fed into the work as heavily as possible without chatter or breakage, due to the fact that a light feed causes the tool to glaze quickly and dull.

Following rough machining all shafts are given a torque test. After being finish-machined they are given a reverse torsional test in a machine especially designed for this purpose. A torque of 45,000 inch-pounds is applied in either direction, this being ten times the calculated maximum stress occurring in service and being close to the elastic limit of a forging of the same design. Although this shaft possesses about the same modulus of elasticity as the forged shaft, the cast shaft is capable of withstanding repeated reverse stresses for more than twice the time.

Brinell tests reveal that the exceptional fatigue strength of the cast crankshafts, claimed to be more than twice that of forged shafts, may be attributed to the uniform hardness of the metal from the heart of the core to the surface. This is not true of forged shafts, which show a Brinell hardness varying from the centre to the surface. Before heat treatment the Brinell reading of the cast shaft is 340 to 360, and when finished from 255 to 321, with the average hardness around 300.

The electric furnace installation is the first completely automatic unit in Canada. It utilizes 10-inch electrodes and pulls 2,400 kv.a. from the Ford power house. One unit in the power house provides the electricity.

Unwin Memorial Fund

The late Dr. W. C. Unwin will long be remembered for his services on many large engineering problems as well as for his educational work. Dr. Unwin died on March 17th, 1933, in his ninety-fifth year, and thus outlived most of his contemporaries. During his long life he was the recipient of nearly every honour that could be conferred upon him by his fellow engineers. He was president of the Institution of Civil Engineers in 1911, and of the Institution of Mechanical Engineers in 1915, and again in 1916; both institutions conferred upon him the distinction of honorary membership. In 1921 Dr. Unwin was awarded the first Kelvin Medal, the highest honour bestowed by British engineers. In America, where he was so well known for his work on the International Niagara Commission, he received many marks of appreciation, among which were the honorary memberships of the American Society of Civil Engineers and the American Society of Mechanical Engineers.

Many of his former students in Canada will be interested to hear that a memorial fund is now being collected by a committee in London under the chairmanship of Sir Alfred Chatterton, the proceeds of which will be devoted to a scholarship fund, to the publication of an extended memoir, and to a portrait to be hung in the Central Technical College, which was for so many years the scene of his labours. Contributions to the fund, and orders for copies of the memoir, may be sent to The Treasurer, Unwin Memorial Fund, 15A Grosvenor Mansions, 82 Victoria Street, London, S.W.1.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

There were twenty-seven persons present at the regular monthly meeting held after dinner at the Prince Edward hotel on February 15th, 1935.

O. Rolfson, A.M.E.I.C., presented the councillor's report. The activities at the General Meeting were reported upon by our member, R. A. Spencer, M.E.I.C.

Owing to the inability of Dr. Clements to attend as announced, B. Candlish, A.M.E.I.C., introduced Mr. T. A. Boyd of the General Motors Research Laboratories, Detroit, who presented a paper on the "Value of Research to Industry."

The first question asked by visitors to an automobile laboratory is "What is the use of all this research anyway? The automobile is just as perfect as it ever will be." This idea is all wrong for even as far back as 1909 one manufacturer advertised the perfect car. One has only to look back a few years to see what progress has been made during the intervening years. The automobile has been a gradual development, not one big discovery or improvement.

However, discoveries and inventions do not spring forth suddenly but are the results of long tiresome hours of research. The most important thing in research is the ability to get new ideas. Only a small percentage of ideas are new or practical.

The history of all new ideas is quite similar. At first presentation it is thrown into the waste paper basket without consideration, similarly for the second and even the third time. After persisting for several years, if your idea is still good, it will get the notice which it deserves.

There is much room for improvement in present day cars. They could be more dependable, have lighter and smoother engines; better carburetion and ignition; improved transmission; easier and safer brakes; and many other mechanical advantages.

After a number of slides had been shown the meeting was thrown open to discussion.

The one method of research in laboratory work, is to put a man in a laboratory and let him work unhindered on any ideas he may have and in any way he likes. The other and the more common way, is to put a man at work solving one definite problem.

H. J. A. Chambers, A.M.E.I.C., and L. E. Krebser, A.M.E.I.C., moved a vote of thanks to Mr. Boyd for his excellent paper.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

Weather Forecasting

At a joint meeting of the Hamilton Branch of The Institute and the Hamilton Centre, Royal Canadian Astronomical Society, at McMaster University on April 22nd, 1935, Mr. John Patterson, F.R.C.S., addressed the gathering on the subject of "Weather Forecasting."

Mr. Patterson after being introduced by Dr. Dawson of McMaster University, told the meeting of the value of forecasting to shipping and farm areas, as well as to the populated districts. He described a great chain of Canadian meteorological stations working in conjunction with the United States stations without which only half the story would be evident.

By diagrammatic slides Mr. Patterson demonstrated the cutting of warm wave fronts into cold bodies with very definite lines of demarcation over the continent. Strange as it may seem, the warm and cold bands may lie side by side, unmixing for great periods. Warm air of course is saturated with moisture to a much greater extent than cold, giving rise to precipitation on meeting the cold wave front. The driving force of the cold band may lift the warm air in mass and give heavy rains.

The cold front is preceded by a "roll-cloud" formation with winds of 15 to 20 miles per hour. In the cold region the sky may be bright and clear while at the junction of hot and cold fronts rains will be pronounced. The winter systems have great variations and are much more difficult to show graphically.

The lecture was further illustrated by motion pictures of cloud formation and dissolution, at high speeds. The pictures were taken from a mountain top in Oakland, Cal., and showed clouds rushing by, increased in motion by the camera to a speed of six times that actually photographed. Clouds were shown to form on meeting a cold current and to dissolve when passing into warm paths over hills.

A vote of appreciation was passed for a most interesting lecture and the meeting adjourned for refreshments.

Several members of the Branch journeyed to Welland on the afternoon of May 2nd and enjoyed the programme arranged by the Niagara Peninsula Branch of The Institute and the Ontario Section A.S.M.E., visiting the plants of the Page-Hersey Tube Company and the Atlas Steel Company, also the heavy forging and the drop forging plants of the Canada Foundries and Forgings Ltd.

Following the visits dinner was served, then followed a meeting which was both instructive and enjoyable. The Niagara Peninsula Branch is to be congratulated on carrying out so successfully such an elaborate programme.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

A joint meeting with the A.S.M.E. (Ontario section), was held in the city of Welland on May 2nd, 1935, with about 250 members attending. The afternoon session was devoted mainly to visiting the following plants:—

Canada Foundries and Forgings	Heavy and drop forgings.
Canadian Atlas Steels Ltd	Tool and special steels.
Page-Hersey Tubes Ltd	Pipe and tubes.

Other industries which were also open for inspection through the kindness of their Executives are as noted below:—

Plymouth Cordage Co.	Empire Cotton Mills Ltd.
Dominion Fabrics Ltd.	Standard Steel Construction Co.
Mead-Morrison Co. Ltd.	National Refractories Ltd.
Welland Electric Steel Foundry.	John Deere Mfg. Co. Ltd.

After an excellent dinner, which was served by the ladies at the Raymond Auditorium, motion pictures were presented showing the process at the Atlas Steels plant and slides to illustrate papers by Messrs. M. F. McCarthy, R. McGlone and Mr. Voorhees of the Erie Forge Company. These combined addresses reviewed the history of forging, the rapid growth in the use of alloys and their particular application, the practical problems of forging and heat treating and pictures of micrographic structure as well as some of the heavy forgings for crankshafts, guns, etc., which are now being used.

Mementoes of this visit, in the form of paper knives and ash trays, were distributed among the guests; also a number of prizes, donated by various local firms, were drawn for by means of a free raffle and presented by Mr. Batchelder.

C. H. McL. Burns, A.M.E.I.C., acted as chairman of the committee, which is to be congratulated upon an excellent programme. Other members of the local committee were Messrs. F. L. Haviland, M.E.I.C., of the Standard Steel Construction Company; Paul E. Buss, A.M.E.I.C., of the Provincial Paper Mills; J. C. Street of the Welland Water Works; E. P. Johnson, A.M.E.I.C., of the Welland Ship Canal; N. A. Batchelder of the Empire Cotton Mills.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

Geological Mapping with Aeroplane Assistance

How the aeroplane can prove of tremendous assistance in the geological mapping of the Pre-Cambrian regions of Northwestern Canada was ably described in a noon luncheon address by F. J. Alcock, Ph.D., of the Geological Survey of Canada, at the Chateau Laurier before the local Branch on April 25th, 1935. Dr. Alcock, who has made a special study of Pre-Cambrian geology, was engaged during the summer of 1934 on a geological exploration of the area in northern Saskatchewan lying north of the Churchill river and drained by two of its tributary streams, the Mudjatik and Haultain rivers. The exploration was a co-operative undertaking between the Dominion and the Saskatchewan governments.

A flying boat was placed at the disposal of the party as well as a radio receiving set and a wireless sending set. With the flying boat it was a simple matter to keep the party well supplied with provisions and to transport the party from one place to another without the laborious work of canoeing and portaging over long distances. By means of the wireless equipment communication was maintained with Ile-a-la-Crosse, the nearest wireless station. Through this station the party was able, in turn, to keep in touch with Prince Albert and other points in civilization. The party also had the advantage of detailed maps of the area prepared from aerial photographs previously taken by the Royal Canadian Air Force, as well as copies of the photographic prints themselves for direct reference.

Canoes, of course, had to be used for the ground work proper and frequently side trips by canoe had to be made for a few days at a time, in which case usually two men would take part and all equipment was so reduced that only one trip across the portages would be required. For some particularly inaccessible regions the plane would frequently be used when it would land the party on a nearby lake with a small folding canvas canoe.

The region covered, stated Dr. Alcock, was one where the relief was somewhat more pronounced than usual with the Pre-Cambrian formation. Hills up to 300 feet in height were quite common; the streams in general were small, and many of the water areas lay in deep basins difficult of access.

The work was greatly speeded up by the plane and much investigation, non-productive of results, was obviated merely by inspection from the air.

Dr. R. W. Boyle, M.E.I.C., chairman of the Branch, presided, and in addition head table guests included: Hon. W. A. Gordon, Major General A. G. L. McNaughton, M.E.I.C., Dr. C. Camsell, M.E.I.C., Dr. W. H. Collins, G. J. Desbarats, M.E.I.C., L. L. Bolton, M.E.I.C., J. A. Wilson, A.M.E.I.C., F. C. C. Lynch, A.M.E.I.C., F. H. Peters, M.E.I.C., Alan K. Hay, A.M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., and Dr. J. H. Parkin, M.E.I.C.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

La Canalisation du St-Laurent

Ce sujet est évidemment d'envergure trop vaste pour être traité à fonds dans l'espace d'une vingtaine de minutes, mais, lors d'une réunion générale de notre section, tenue au Palais Montcalm le 4 mars dernier et spécialement organisée pour mettre en vedette le groupe de nos jeunes membres, M. René Dupuis, A.M.E.I.C., assistant surintendant de la division du pouvoir à la Cie Quebec Power, nous a donné un aperçu remarquable de l'ensemble du projet.

Monsieur Dupuis traite d'abord de la géographie du St-Laurent dont la longueur, à partir du détroit de Belle-Isle jusqu'à l'extrémité ouest du lac Supérieur, est de 2375 milles; sous la rubrique distances verticales il mentionne que Montréal est à 20 pieds au-dessus du niveau de la mer, le lac Ontario à 245 pieds, le lac Erié à 570 pieds, le lac Michigan à 580 pieds et enfin le lac Supérieur à 600 pieds.

Cette chaîne de lacs forme un immense réservoir d'environ 95,000 milles carrés et assure au fleuve une stabilité de débit naturel unique au monde; le conférencier nous fait ensuite remonter le St-Laurent jusqu'à ses sources en notant les profondeurs d'eau jusqu'à Montréal et les différents rapides à l'ouest de ce dernier endroit.

Dans la seconde partie de sa causerie Monsieur Dupuis donne la liste des différents canaux avec leurs caractéristiques respectives soit: la longueur en milles, le nombre d'écluses et de pieds de montée, puis la profondeur d'eau. En passant le conférencier s'arrête quelque peu sur la diversion des eaux du Lac Michigan par la ville de Chicago, et énumère les motifs de la construction de ce canal de diversion et démontre que cette dernière a pour effet d'abaisser le niveau de l'eau de plusieurs pouces dans le port de Montréal qui en souffre gravement.

Les canaux projetés devront avoir les caractéristiques du canal Welland dont la profondeur est de 25 pieds; le fleuve St-Laurent avec ses canaux forme un cours d'eau navigable depuis son embouchure jusqu'à la tête des grands lacs; les sujets de sa Majesté Britannique et des Etats-Unis ont le droit d'y naviguer en vertu de traités dont le conférencier nous cite certaines clauses se rapportant à la navigation.

Un bref aperçu est aussi donné des forces hydrauliques utilisables le long du fleuve.

En troisième lieu Monsieur Dupuis parle du coût anticipé de la canalisation et du revenu qu'on en attend, il donne dans cette partie une foule de chiffres très intéressants mais que nous ne pouvons citer faute d'espace et pour conclure le conférencier énumère les raisons "pour" et "contre" la canalisation sans en faire l'appréciation.

A cette même réunion nous avions le plaisir d'entendre MM. James O'Halloron, A.M.E.I.C., et Jean St-Jacques, S.E.I.C., sur des sujets très intéressants; un résumé de leurs causeries sera publié prochainement dans la section des "Branch News" du Journal de l'Institut.

Sault Ste. Marie Branch

H. O. Brown, A.M.E.I.C., Secretary-Treasurer.

Construction of a Modern Highway

The Sault Ste. Marie Branch held the general meeting for April at the Windsor Hotel on Tuesday evening, April 30th, 1935, instead of on the regular meeting night of Friday, April 26th. This was arranged for the convenience of the speaker for the meeting.

The dinner preceding the meeting was well attended and twenty-seven members and guests sat down at 6.45. Following the dinner the chairman, F. Smallwood, M.E.I.C., called the meeting to order.

After the routine business was transacted the chairman introduced the speaker of the evening, Mr. R. T. Lyons, B.A.Sc., of the Department of Northern Development, Sault Ste. Marie. Mr. Lyons' subject was "Construction of a Modern Highway," illustrated with photographs and lantern projection views.

Starting with reconnaissance surveys of the proposed road by aeroplane, the various steps in the development of the standard 30-foot gravel highway were described. Most of the photographs shown had reference to the construction work done in the Kenora area on the Trans-Canada Highway, and, therefore, were of special interest at this time owing to the discussions which have taken place about the proper location for the connecting link between this district and Kenora.

Another feature of road-building and maintenance which is of special interest at this time in this area is dust laying. The relative merits and costs of the oil treatment and calcium chloride treatment were referred to by the speaker.

After the address further information was brought out by the questions presented by the members. The discussion indicated that the majority present had a very active interest in the subject.

At the close of the discussion the chairman, on behalf of the Sault Ste. Marie Branch, thanked Mr. Lyons for addressing the meeting

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Modern Sewage Treatment

On April 18th, 1935, W. D. Hurst, A.M.E.I.C., gave a paper entitled "Modern Sewage Treatment." The subject was of particular interest to Winnipeg engineers because of the proposed scheme of interceptor sewers and a treatment plant for that city.

At the present time the Assiniboine and Red rivers are carrying the discharge from 49 untreated main outlets and 12 private outlets, in Greater Winnipeg, which with the present low flow in the rivers has resulted in nuisance conditions. The speaker outlined three criteria whereby nuisance due to sewage in a stream is currently judged, namely, if the river flow be less than 3.5 c.f.s. per 1,000 population, if the dissolved oxygen in the river water fall below 50 per cent, or if the ammonia content of the water exceed a certain percentage. Interesting slides were shown demonstrating that for the last years, these three boundary lines had been definitely transgressed. Other information was presented which showed that increase in river flows of sufficient amount to alleviate these conditions in the next few years was exceedingly doubtful. The proposals for a system of interceptor sewers, to convey the discharge to a treatment plant north of the city, were outlined.

A wide variety of treatment processes, from mechanically cleaned screens to the incineration of the sludge, were described, and illustrated by a large number of slides.

Those contributing to the lengthy discussion which followed included D. L. McLean, A.M.E.I.C., Wm. Aldridge, A.M.E.I.C., J. W. Porter, M.E.I.C., E. V. Caton, M.E.I.C., W. M. Scott, M.E.I.C., T. C. Main, A.M.E.I.C., G. E. Cole, A.M.E.I.C., and Chas. T. Barnes, A.M.E.I.C. Mr. G. E. Cole paid tribute to the mining engineer Dorr for his extensive inventions of metallurgical machinery which had been so widely adapted to sewage treatment.

A hearty vote of thanks to the speaker of the evening was moved by E. V. Caton, M.E.I.C.

List of New and Revised British Standard Specifications

(issued during March, 1935)

B.S.S. No.

9—1935. *Bull Head Railway Rails.* (*Revision.*)
Introduction of medium manganese quality of rail with analyses and tests and alteration in permissible percentage of short lengths in the case of rails 60 feet long.

138—1935. *Portable Chemical Fire Extinguishers.* (*Revision.*)
Specification for materials, constructional strength and performance of portable chemical fire extinguishers of the acid alkali or soda acid type.

412—1935. *Engine Testing Equipment.* (*Revision.*)
Includes two further sections, one standardizing dimensions of attachments for testing fittings, i.e. thermometer pockets, etc.; the other to deal with suitable forms of indicator gear to ensure adequate accuracy.

590—1935. *Electrically Welded Mild Steel Chain Short Link and Pitched or Calibrated.*
Provides for sizes, quality and mechanical strength of electrically welded short link pitched or calibrated mild steel chain of sizes ranging from 6 S.W.G. to 17/32 in., representing a range of maximum permissible loads of from 1/5 ton to 1 ton 14 cwt.

591—1935. *Wrought Iron and Mild Steel Hooks of the "C" or Liverpool Type.*
Specifies design and mechanical strength of special type of hook used for unloading of ships, general cargo, and in building operations. Loads ranging from one to ten tons.

592—1935. *Steel Castings for General Engineering Purposes.*
Provides for four classes to cover the normal range of steel castings used in all sections of engineering industry. Requirements included for details of manufacture, heat treatment and mechanical properties.

593—1935. *General Purposes Laboratory Thermometers.*
Provides for workmanship, dimensions and constructional details and figuring of total immersion and partial immersion thermometers for general laboratory work.

599—1935. *Pump Tests.*
Designed to cover determination of performance and efficiency of pumps when handling clean water at temperatures up to 85 degrees F.

601—1935. *Steel Sheets for Transformers for Power and Light.*
Sheets of one thickness are standardized in two sizes. Three qualities of sheet are however specified according to the loss in watts per lb. Other tests include permeability, ageing, finish, etc. Details of methods of testing given in Appendices.

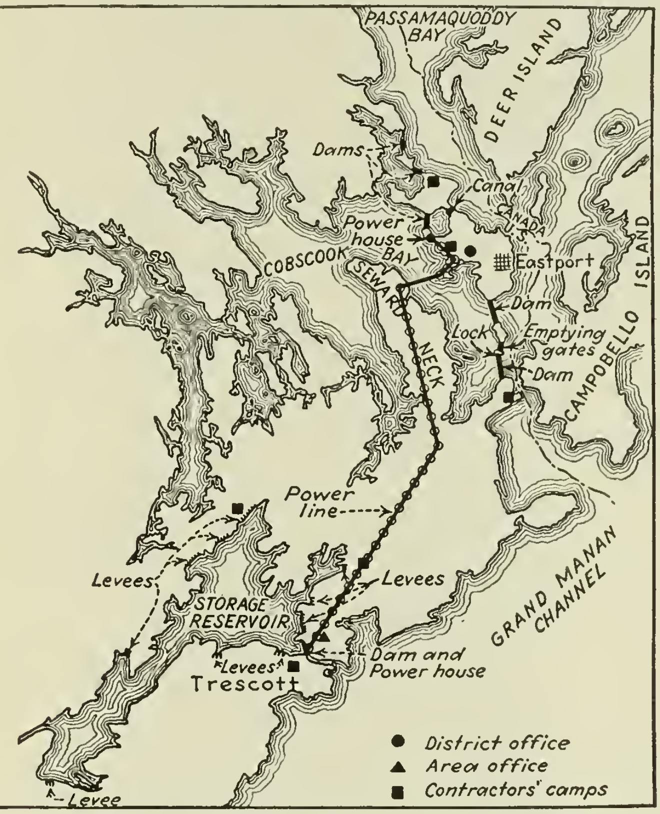
Copies of the new specifications may be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, England, and, in Canada, from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa.

The S. R. Dresser Manufacturing Company, Bradford, Penn., and Toronto, announce a new type of compression coupling, style 65. This is supplied in standard steel pipe sizes from ⅜ inch to 2 inches I.D. inclusive. It is suitable for plain end pipe, no special preparation of pipe ends being needed.

United States Passamaquoddy Power Project

The federal government will take over the construction of the long-discussed Passamaquoddy Bay tidal power project in Maine, if the recommendation of the Advisory Committee on Allotments that $10,000,000 of the relief works funds be allocated to the Corps of Engineers to start construction of that project is approved by the President.

As originally proposed by Dexter P. Cooper several years ago, the project included all of Passamaquoddy Bay (mostly in the province of New Brunswick), Cobscook Bay in Maine and several dams to shut off the two bays from the ocean and to separate them into an upper and lower pool. The present project, as shown in the accompanying



The Tidal Project Originally Designed to Include Passamaquoddy Bay is now confined to the much smaller Cobscook Bay supplemented by a Pumped-Storage Reservoir.

map, includes only Cobscook Bay in the tidal power scheme and adds a pumped-storage reservoir to be located along the coast south of Cobscook Bay.

As has been the case ever since the project was first put forward no engineering drawings of the proposed dams, control gates and power houses have been made public. About a year ago the project was put up to the Public Works Administration for financing but it was disapproved by the P.W.A. board of review, and no details other than the estimated cost of $47,000,000 have been made public. The present project, according to the official statement, is designed to create and maintain a low level pool in Cobscook Bay and to use the difference in head between this pool and the ocean which will vary with the tide, to generate electric energy. The initial development will utilize the head above 5 feet in a main power station with an installed capacity of 166,670 kv.a. but the powerhouse will be constructed for a maximum capacity of 366,874 kv.a. with 12 units not installed. The estimated cost is placed at $36,284,000. The normal range of tide in Cobscook Bay is 18 feet.

The storage reservoir will have a surface elevation of 130 feet above sea level, and surplus power will be used to pump water into this reservoir, to be converted into electric energy during the low tide period. The emptying gate which will control the level of the Cobscook pool, and the navigation lock, will require a cofferdam of 75 feet in depth, capable of withstanding a maximum of 20 feet tidal range and ocean storms. Three of the rock dams are to be placed in water in excess of 100 feet in depth and subject to high velocity due to the periodic reversing of the tide.

The Corps of Engineers has passed upon the practicability but not upon the economics of the project.

Major Philip B. Fleming of the Corps of Engineers who acted as deputy administrator of public works from September 1934 until May 1935, is to be engineer in charge of the Passamaquoddy project for the army engineers.—*Engineering News-Record*

The Development of Building Codes in the United States

For years, architects, engineers, builders, manufacturers and others whose work or products go into building construction in the United States, have complained bitterly about existing building regulations. Architects have said that their freedom of design has been unnecessarily restricted. Engineers and builders have claimed that obsolete or ill-considered code provisions increased building construction costs without adding any compensating benefits in the way of increased public health or safety. Manufacturers of building materials have pointed out that their tested and tried products have been compelled to run a gauntlet of conflicting regulations, and that promising new materials and methods sometimes died in the struggle for recognition.

The public, on the other hand, has voiced its disapproval of poor or uncontrolled construction in no uncertain terms following the destruction wrought by earthquakes, tornadoes, fire, time and other causes. In addition, those who advance money on building construction, those who insure building loans, and those who insure buildings demand sound building regulations as a protection for their investment.

When questions of public health and safety, requirements for countless varieties of building materials and design and construction problems must all be considered in formulating a building code, it is obvious that the procedure requires a broad range of representation and a permanent, long-range plan for insuring retention of advances made, as well as providing machinery for necessary revisions.

A special committee, composed of representatives of national organizations having an interest in the entire building code field and private experts, has been appointed under the procedure of the American Standards Association to investigate methods for continuing the work on building codes of the Department of Commerce Building Code Committee, recently disbanded.

The Department of Commerce Committee was discontinued for reasons of economy and in line with the principle that agencies outside of the government should have an opportunity to participate more directly in the work. The Department of Commerce and the American Standards Association arranged to co-operate in the future development of building code recommendations.

Frequent surveys have brought out the salient facts about the current status of building regulations. There are to-day something like fifteen hundred local codes of all sizes and descriptions in existence in the United States and half a dozen state codes. In spite of sustained efforts to bring about scientific treatment of topics in the interest of safety and health these codes still differ widely in their treatment of fundamentals. Without necessarily recommending complete uniformity in building codes the sentiment is often expressed by architects, building officials, engineers and others that a vast amount of work remains to be done in bringing them up to an acceptable standard.

It is true that there are model codes in existence sponsored by organizations of building officials and by insurance interests. While these have made definite contributions towards better requirements, they differ both in method of presentation and actual provisions.

In general, the task of the A.S.A. committee will be to consider matters of general interest with respect to building codes; to act as an advisory committee to the Association; to consider what subjects are appropriate for development in the A.S.A.; to define and limit the scope of projects for which it recommends sponsors; to follow up work in progress in the development of projects; to review the personnel of committees responsible for building code projects to insure their having a representative character; to examine recommendations submitted by sectional committees and to harmonize conflicts between the several recommendations; and to act upon such other matters that may be brought before it with relation to the development of building codes as it may consider within its province.

Individual projects will be handled by sectional committees, thus affording representation for all those having an interest in one or more phases of building codes, but not in the entire field.

Canadian Standard Forms of Construction Contract

In the editorial dealing with this topic in the January issue of The Journal the statement should have been included that these forms, as approved by the Council of The Engineering Institute of Canada and issued by the Canadian Construction Association, are essentially those originally produced by The Royal Architectural Institute of Canada jointly with the Canadian Construction Association, applying to work executed under the supervision of an architect.

Association of Canadian Fire Marshals and Dominion Fire Prevention Association

On Tuesday, Wednesday and Thursday, June 18th, 19th and 20th, 1935, the joint annual meetings of the Association of Canadian Fire Marshals and the Dominion Fire Prevention Association will be held at the Chateau Laurier, Ottawa.

The Fire Marshals Association will convene on June 18th at 10 o'clock and the Dominion Fire Prevention Association will convene at 2.30 p.m. on June 19th, following a joint luncheon of both organizations.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Wanted

SALES ENGINEER, S.E.I.C.; B.SC. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

Situations Wanted

ELECTRICAL ENGINEER, B.SC. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box. No. 651-W.

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters of Branch secretaries.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

Situations Wanted

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, B.SC. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.SC. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.SC., '25, JR.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

Situations Wanted

CIVIL ENGINEER, B.E. (Sask Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.SC. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No 887-W.

AGENCIES WANTED Young engineer, B.A.SC. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A. C., JR E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

Situations Wanted

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.SC. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.SC. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.SC. Univ Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.SC., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.SC. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W

Situations Wanted

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.SC., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.SC., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Write and speak both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211 W.

CIVIL ENGINEER, B.SC. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

COMBUSTION ENGINEER, A.M.E.I.C., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet and tissues. Apply to Box No. 1246-W.

CIVIL ENGINEER, B.SC. '29, JR.E.I.C., age 29, single. Experience in all types of surveying including use of aerial photographs. Three years on hydro-electric power development in field and office. Instrumentman on concrete road construction. Location immaterial. Apply to Box No. 1254-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No 1265-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '29) Age 28. Six years experience in automobile office and plant; two years as supervisor of inspection in body assembly. Good understanding of modern business methods applied to manufacturing. Desires position with production department of smaller Ontario industry. Good references. Interviews anywhere in central Ontario. Apply to Box No. 1270-W.

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Common-Frequency Radio Broadcasting

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, March 8th, 1934.

SUMMARY.—In the following paper the general problems of common-frequency radio broadcasting are first discussed, the material being mainly compiled from papers previously published in the technical press. The problems include a study of the degree of synchronization required, the relative carrier field strength ratios desired in the service areas, the effects of noise and detector action and calculations on the increased service areas to be expected. There follows a description of two methods of securing synchronization: radio-frequency monitoring method, and electric control over wire lines between the stations. Commercial types of apparatus are briefly discussed, and the results of field tests given.

Common-frequency radio broadcasting, or less accurately, synchronized broadcasting, is a phrase used to describe a radio transmission system whereby two or more radio transmitters operate with the same carrier frequency. In an older parlance, the stations have the same wavelength. In this definition the quite common situation is not discussed where two stations operate on the same frequency, but are so widely separated geographically that neither one lays down an appreciable signal strength inside the territory covered by the other station.

Consider primarily the conditions existing when two or more stations operate on the same frequency, and radiate sufficient power, or are so closely spaced, that their areas of appreciable field strength overlap to some extent, or at least the "nuisance area" of one station overlaps the "service area" of the other. These terms are self-explanatory. To one not previously acquainted with the subject, it is not at once clear just what problems will be involved. It may safely be concluded, however, that some or all of the following questions will have to be answered:—

A. When the two stations are on the same frequency, how closely will this condition have to be met? Will not the allowable difference in frequency depend on relative carrier strengths of the two stations, relative depths of modulation, whether the stations are carrying the same, or different, programmes? Will not the type of receiver used, and particularly the demodulation or detection device be important?

B. If some law of radio wave propagation is assumed, what is the normal service area of two stations, not synchronized? How much will this service area be increased by synchronization?

It seems fairly clear that one may also want to look into the economic questions, glance at some existing installations, and finally consider what results have been achieved in field trials.

Purpose of Synchronization

Now to retrace our steps a short way, and consider, as the Marx Brothers would say, "Why is a synchronized station?" The answer is at once: there are not sufficient frequency channels available in the broadcast band. Table I shows the situation clearly.

Table I
Division of Radio Broadcast Spectrum in North America

	No. of Existing Stations	No. of Clear Channels	No. of Shared Channels	Total Number of Channels
Canada	70	9	27	36
United States	422	20	45	65
Mexico	62	0	48	48
Cuba	56	0	40	40
Totals	610	29	68*	97

Canadian clear channels: 540, 690, 730, 840, 910, 960, 1030, 1050 and 1100 kilocycles.

*Total number of shared channels equals total number of channels less total number of clear channels.

At the present time the broadcast band in North America extends from 540 kc. to 1500 kc., inclusive. Channels are 10 kc. wide, so that there are available ninety-seven different carrier frequencies. After the radio conference at Mexico City in July and August of 1933, these channels were allotted as shown, and Canada secured nine clear channels and twenty-seven shared channels, these to be divided among seventy stations. This situation means that many frequencies must be shared between two or more stations. With wide separation, or low power, little interference results. In some cases, however, it is highly desirable to operate additional stations within a given area, in order to give good service to the listening public, and it is here that synchronized broadcasting may prove of great value.

A second place where synchronization shows advantages is in the satellite system. Consider a hypothetical transmitter located say in Montreal, which gives good signal strengths about and beyond Sherbrooke, some 80 miles distant, but which fails to deliver a satisfactory signal in the town itself, due to local electrical interference. A low-power transmitter might then be installed in Sherbrooke, designed to cover the town only, and it would be advantageous to synchronize the Sherbrooke and Montreal transmitters.

There is also another aspect of synchronization. In the example given above, it would not have been economical to increase the power of the Montreal transmitter merely to increase the signal strength at Sherbrooke. There might also be the case where it might be economical to increase the main transmitter power, but in doing this, so high a signal strength would be delivered to nearby areas, that the local receivers would be unable to receive anything except the local station, and also the nuisance area of the station on the outskirts of its service area would be increased beyond the tolerable limits. Again synchronization might prove of value.

Fig. 1—Relative Density of Population in Canada.

In Canada common-frequency broadcasting is of especial interest. There is a large area to be covered, with a comparatively small population, which means many stations, but few channels. Moreover, the population is settled in fairly concentrated areas separated by considerable distances. It will be seen that this situation lends itself admirably to synchronization. There is given in Fig. 1 a map of Canada with density of population shown, which shows clearly the extent of this concentration of population. And last, and most important, radio broadcasting is under a unified control, an absolute necessity where extensive synchronized systems are to be intelligently planned. This principle may thus become one of the most important factors in Canadian radio development.

Reception of Synchronized Stations

Now to attack the technical phases of the problem by considering the reception of two synchronized stations in detail. First consider the case in which the stations carry the same programme, and the difference of frequency of the carriers is of the order of a few cycles per second. Waves from both stations are amplified by the high-frequency stages of the receiver, and reach the detector, where a number of spurious frequencies are generated. Table II shows these in detail.

Table II

Detection of Two Modulated Waves

Audio-frequency components for waves of carrier frequency-difference ΔP, carrier amplitude ratio K, depth of modulation of each wave M, frequency of modulation Q for each wave, waves modulated in phase, square-law detector.

Frequency of Component	Relative Amplitude $M, K.$	Relative Amplitude $M=1.0$ $K=1.0$	Description
Q	$1+K^2$	1.00	Desired Frequency.
ΔP	$\frac{K}{M}\left(1+\frac{M^2}{2}\right)$	0.75	Beat Frequency.
$Q+\Delta P$	$K.$	0.50	Desired Frequency + Beat.
$Q-\Delta P$	$K.$	0.50	Desired Frequency − Beat.
$2Q$	$\frac{M}{4}(1+K^2)$	0.25	2nd Harmonic.
$2Q+\Delta P$	$1/4\ MK$	0.125	2nd Harmonic + Beat.
$2Q-\Delta P$	$1/4\ MK$	0.125	2nd Harmonic − Beat.

There is first shown the amplitude of the various components as a function of the depth of modulation, M, and of the ratio of the carrier amplitudes, K. These values have then been computed for the case of 100 per cent modulation and equal carrier amplitudes. This is about the worst case to be encountered. What should be noted here particularly is that not only is the beat note of importance, but other components are also present, principally those having frequencies equal to the modulation frequency plus or minus the beat frequency. Since in practical cases the beat frequency is much too low to be heard, it is these latter components which impair the quality.

In Fig. 2, in order to give a more general picture of the production of spurious frequencies, there are shown their relative amplitudes as a function of the ratio of the carrier amplitudes, for 50 per cent modulation. If it is assumed that for satisfactory reception the relative amplitude of the total sideband noise should not be more than one-tenth that of the desired frequency, this would restrict reception from two stations to areas where the relative carrier amplitude is 20 to one or greater. A series of measurements to determine this point has been made by G. D. Gillett,* and his results are shown in Fig. 3. Tests were made with both music and speech, running up to 80 per cent modulation on peaks. With voice transmission the situation was the less critical, but in general a carrier ratio of 10 to 1 had to be maintained in order to avoid serious impairment of quality.

The next problem for consideration is the reception of two synchronized stations, carrying the same programme, when the carrier frequency difference is made very small, of the order of one cycle or less. The waves may be considered to be of the same frequency, but with a phase difference which slowly varies. Under these conditions reception is obtained very different in character to that previously considered. In the first place the beat frequency is absent. This in itself is of little importance, but the concomitant result is that the spurious frequencies made up of the modulation frequency plus or minus the beat frequency are also absent. The removal of this sideband noise gives a freedom from harshness in the sound reproduction, to an extent not easily obtainable when the carrier frequencies are appreciably different. An important

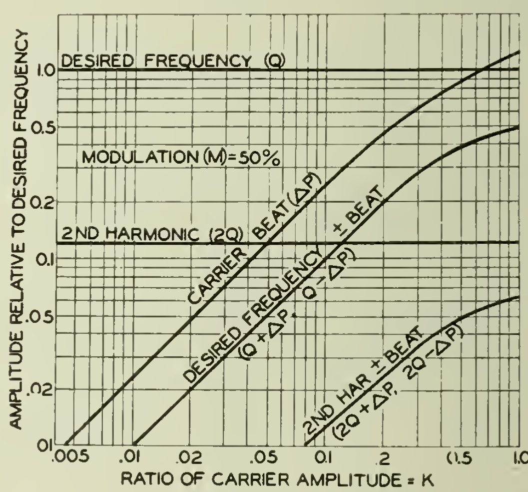

Fig. 2—Detection of two modulated Waves of Frequency-Difference ΔP, each modulation 50 per cent in Phase, by Frequency Q. Curves show relative Amplitude of Audio-Frequency Components in Output of Receiving (Square-Law) Detector.

effect to be considered is the way in which the two carrier waves add together in the detector. Assume for an example that the signal strength from the two synchronized stations is equal. Then when the two carriers are in phase aiding, twice the voltage due to either station alone is applied; when the carriers are in phase opposition, the resultant voltage is zero. As the carriers change phase through 180 degrees, or as the receiver is moved across the country

*Previously published material used in the preparation of this paper is listed in the bibliography under the appropriate subject heading.

one-half wave length, a signal strength is received varying from zero to twice the normal value. For areas where the carrier amplitudes are not equal, the variations will be smaller. In Fig. 4 an assumed case has been plotted. The central curves show the relative field strengths received separately from two hypothetical stations of equal power, 150 miles apart. The upper curve shows the sum, and the lower curve shows the difference, of the field intensities from the two stations. Then at any one position the signal amplitude will vary between these two limits. The

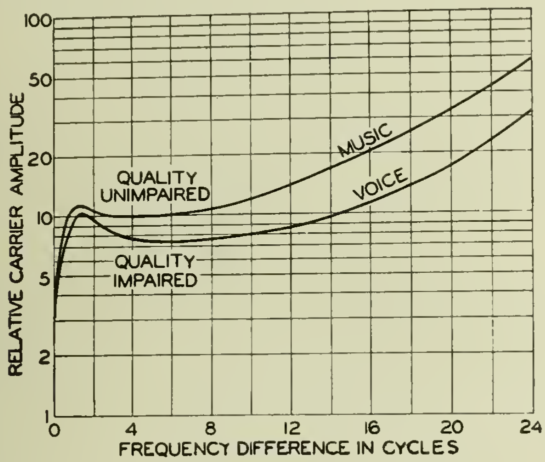

Fig. 3.

most obvious result will be fading. It is usually concluded that this factor is negligible, due to the prevalence of receivers incorporating automatic volume control, and in the small area where the resultant signal goes below the noise level during the fading cycle, it is stated that a slightly directional antenna will solve the problem. Surely these conclusions are much too optimistic. It is doubtful if at the present time one receiver in three in Canada has an effective automatic volume control circuit, and in the area of equal strength probably not one listener in ten would have the knowledge, the facilities, and the energy to erect the simplest form of directional antenna. The manner in which an opinion is reached on these two points, simple as they may seem, profoundly affects the design of any synchronized broadcasting system.

If it is assumed that a fading ratio is permissible between peaks and troughs of 1.4, or 3 db., then reception is restricted to areas where the relative signal strength ratio of the two stations is about six to one, or greater. If, however, an increased fading ratio is permitted, other

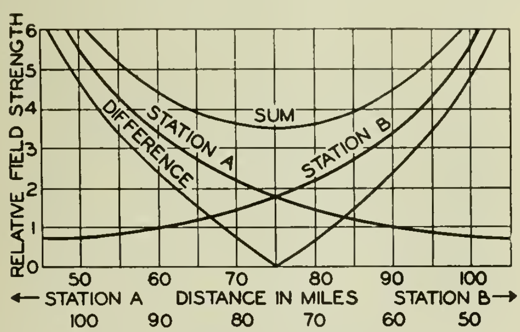

Fig. 4—Field from Two Synchronized Stations of Equal Power.

factors demand attention. The first of these is the question of the depth of modulation.

The usual type of receiver can receive with tolerable distortion a modulated wave in which the sidebands are of equal amplitude, and separately do not exceed half the carrier amplitude, i.e., the depth of modulation does not exceed 100 per cent. Since the carrier and sidebands are not of the same frequency, one of the following conditions may be obtained, depending on the relative phase of the waves from the two stations, at the receiving point.

(*a*) Both sidebands completely or partly phased out, causing amplitude fading additional to the carrier fading already considered.

(*b*) One sideband phased out, causing some fading, but principally severe distortion of the modulated wave.

(*c*) Carrier fading, without sideband fading, which may cause the resultant wave at the receiver to be overmodulated, with consequent distortion upon demodulation.

(*d*) Where the modulation takes place at several frequencies simultaneously, certain of these frequencies may phase out and be lost at the receiver, with a resultant loss of fidelity; this is selective fading, and is usually accompanied by (*b*) and (*c*).

(*e*) Where the audio-frequency modulating waves are out of phase results similar to (*d*) may result.

Figure 5 shows the relative amplitude of second harmonic components for the case of equal carrier amplitudes over a range of carrier and modulation phases, as measured at the output of the receiving detector.

There remains one more case to be considered. This is the effect of difference in time of arrival of the corresponding waves from two exactly synchronized transmitters. Echo effects are easily avoided in practical operation, as delays of several thousand micro-seconds are ordinarily required before these become perceptible. However, much

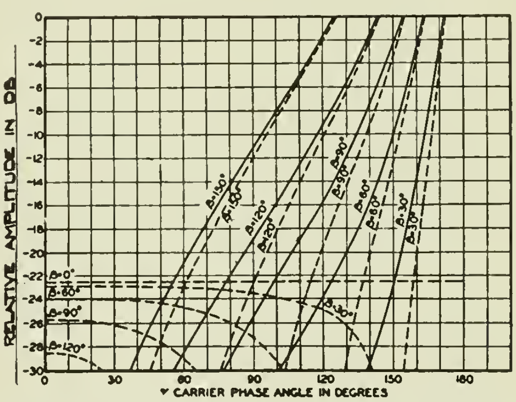

Fig. 5—C.-F. Broadcasting Detection of two Modulated Waves. Second Harmonic Output for Waves of same Amplitude and Frequency Modulated 30 per cent by same Frequency.

smaller delays have been found quite perceptible from a distortion standpoint, due to the phasing effects of the two modulated waves. Figure 6 shows the results of observations by Aiken on the relative time-delay which is permissible for various ratios of carrier amplitude and various carrier phase angles. It will be noted that the worst effects are obtained with a carrier phase angle of 180 degrees and in Fig. 7 the permissible time-delay, or alternatively the permissible difference in distance from the receiver to each of the synchronized stations, is plotted against the required carrier amplitude ratio. If a carrier ratio of about 14 or more to one is maintained, time-delay of any reasonable amount causes negligible distortion. On the other hand, if the stations are accurately synchronized, and the difference in the length of paths to the receiver is less than 10 miles, perfect reception may be obtained at any point in their normal service area.

Some consideration should be given to the type of detector employed in the receiver. In most of the calculations of spurious frequencies the linear detector shows to considerable advantage over the square-law detector. In practice, however, as the actual conditions of carrier ratio, frequency difference, depth of modulation, and time-delay vary widely, and as commonly used detectors are intermediate between the two theoretical types, very little distinction can be made. In general, of course, the linear detector will show smaller relative distortion components.

So far only the case where the two synchronized stations carry identical programmes has been considered. When stations carrying different programmes are synchronized, however, very little advantage is ordinarily gained. The beat note will normally be inaudible in any case, and the only spurious frequencies which will be eliminated are the desired frequency plus and minus the beat frequency. These components will be much smaller than the components of the unwanted modulation frequency, so that about the same carrier ratio must be maintained at the receiver for synchronized as for non-synchronized stations.

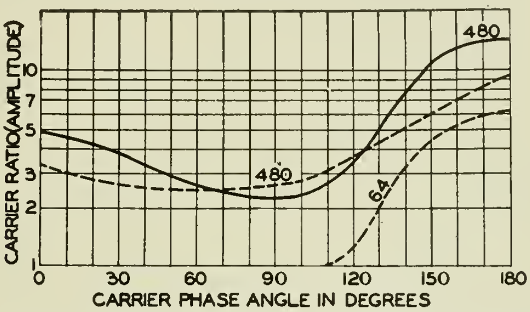

Fig. 6—Detection of two Modulated Waves of same Carrier Frequency, modulated 80 per cent on Peaks of same Programme. Curves show limiting values of Carrier Phase Angle and Carrier Amplitude Ratio at which indicated Time-Delay in Microseconds causes Perceptible Distortion.

There is also another effect in the reception of synchronized stations which becomes important when the frequency-difference is greater than about one cycle. If static or circuit noise is present in even quite small amounts, a noticeable flutter will be heard, although the carrier ratio may be of such a value that reception is otherwise satisfactory. This effect has been extensively studied by C. B. Aiken of the Bell Telephone Laboratories, who kindly permitted the writer to see an unpublished memorandum giving complete quantitative data.* This flutter is much more noticeable with a square-law than with a linear detector, and in the former case is independent of the amplitude of the noise over quite a wide range. As a quantitative example, Aiken found that with two carriers of a frequency-difference of 3 cycles, the stronger signal being modulated by speech or music with a strong background of circuit noise, the square-law detector gave easily perceptible flutter for a carrier amplitude ratio of 3 to one, the flutter becoming imperceptible for ratios greater than about 6 to one. Under similar conditions the linear detector gave perceptible flutter for a carrier ratio of 1.2 to one, distortion disappearing for a ratio of about 1.8 to one.

The flutter effect may also be intensified with receivers employing automatic volume control. As the two incoming carriers alternately add and subtract in amplitude, the automatic volume control will first increase and then decrease the gain of the receiver in order to keep a constant carrier voltage at the detector input, thus causing a corresponding flutter in any background of noise which may be present.

This section may be concluded with a rough estimate based on the experience of workers in the field of synchronized broadcasting, as to what ratios of carrier amplitudes from the two transmitters are permissible for satisfactory reception.

For accurate synchronization, with carrier-frequency differences of a fraction of a cycle, and small time-delay, ratios of 1.4 to one or greater must be maintained. Eckersley gives a ratio of 5 to one for low-power stations of equal power separated forty miles.

*Since this paper was written, Mr. Aiken has published the results of his study. See reference (10) in bibliography.

For close synchronization with carrier frequency-differences of a few cycles, ratios of about 12 to one or greater are necessary, particularly if noise is present.

For stations without synchronization having frequency-differences of the order of 20 to 100 cycles, the carrier ratio should be about 30 to one or greater.

It is a fact of experience that where synchronized stations are received at a considerable distance from either station, or in cases where the stations are widely separated, reception may be much better than would be predicted from the data given above. This is due to the fact that in these cases transmission from each station may occur over several paths of different lengths. All the effects tending to depreciate the quality of reception depend on the phasing-out of particular components, and where a number of paths exist, the probability of these phasing effects becoming serious is considerably lessened.

Service Area of a Single Station

Having considered in some detail the reception of two synchronized stations, the associated transmission problems may be now looked at briefly. The steps necessary are first to arrive at conclusions as to what constitutes a satisfactory signal strength, and then to examine available data to find the extent of the service area of a single station operating on a clear channel. With this information on hand we shall be able to see to what extent synchronization is of value.

The United States Federal Radio Commission has set up standards for reception as follows:

The *good* service area of a station is defined as that area in which reception is obtained free from noticeable interference for 90 per cent of the time. *Fair* and *poor* service areas are defined relative to the good service area. The field intensity which is considered to correspond to each grade of service for different reception conditions is shown in Table III.

Table III

Minimum Field-Intensity Standards Established by the U.S. Federal Radio Commission

Values are in millivolts per meter

District \ Service	Good	Fair	Poor
Business	10	5	2
Residential	2	1	0.5
Rural	0.5	0.25	0.125

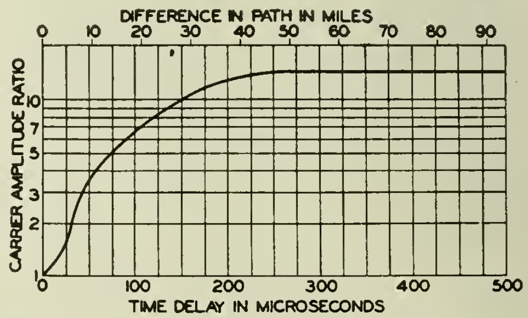

Fig. 7—Detection of two Modulated Waves of same Carrier Frequency, of Relative Phase 180 Degrees modulated by same Programme. Curve shows Time-Delay (or Difference in Lengths of Path to Receivers) versus Carrier Amplitude Ratio at which Distortion is just Perceptible.

A standard for non-synchronized stations of the same frequency is set at a field-intensity ratio of 20 to one, although admittedly this is not satisfactory under many conditions.

Definitions of service areas in northern Europe, given by P. P. Eckersley, sometime chief engineer of the British Broadcasting Corporation, agree with the values shown in Table III for business districts.

It should be realized that the classifications arrived at, in America at any rate, are governed almost entirely by local electrical noise conditions. It is assumed that listeners in any area will have receivers sufficiently sensitive to utilize even much weaker field intensities than are accepted as satisfactory.

Now to consider the question of the field due to a broadcasting station. The field intensity laid down by a station at a given point is greater during the night than in the day, the ratio between the two values growing greater as the distance from the station is increased. In synchronized broadcasting one station on the channel is generally at a considerably greater distance from a receiver in the good service area than is the other station. The greatest impairment of reception occurs when the distant station has its maximum field intensity, hence night-time conditions are of the greater importance. Accordingly in Fig. 8 curves are shown relating field intensity and distance from the station, for a wide range of antenna power. These curves are the average of several hundred night-time observations on American broadcasting stations, co-ordinated by the United States Federal Radio Commission. In situations where stations of widely different powers are synchronized, reception at some points may be governed by the day-time field intensity ratio. The curves of Fig. 8 may be used for estimating field intensities in these cases, up to distances of 20 miles.

The data used in drawing Fig. 8 were averages only, and in individual cases the actual field intensity may vary above or below the value shown by a factor of 5. It will be noticed that these curves show the transmission as obeying quite closely an inverse-distance law. Similarly the day-time transmission obeys an inverse-square law at distances from 20 to 200 miles.

Service Area of Synchronized Stations

One is now in a position to calculate the area and the population served by a single station; and also to estimate these quantities for a pair of synchronized stations.

In order to clarify the situation, Fig. 9 has been drawn to show the field-intensity ratio contours around one

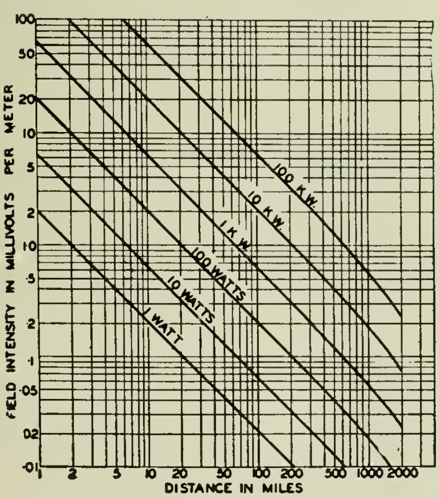

Fig. 8—Average Night-Time Field Intensities.

station of a synchronized pair. Underlying assumptions are made that the stations are of the same power and that the inverse-distance law holds throughout the region covered. In regions of greater attenuation, or where greater distances are covered, the contours will not lie so close to the station, that is, the service area will be increased.

Commercial Synchronizing Equipment

Common-frequency broadcasting has been attempted in many cases with varying degrees of success, but at the present time appears to be of particular importance, partly due to a general increase in transmitter power both here and in Europe, and partly due to recent progress in synchronizing equipment.

Perhaps the most ambitious system that has been operated is the British Broadcasting Corporation's chain

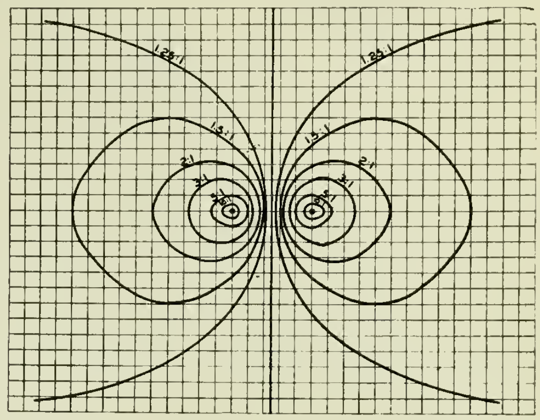

Fig. 9—Field Intensity Ratio Contours around Two Synchronized Stations of the same Power.

of ten stations, set up on the basis of satisfactory results realized as early as 1926 from four British stations synchronized within a hundred cycles or so, and from two German stations operated synchronously in 1928. In the B.B.C. system, 1,000-cycle tuning forks were used at each station with a series of doubler stages to give the carrier frequency. Stability was maintained within about 10 cycles, and the forks were probably re-adjusted every few days to the frequency of a master station. The system apparently operated with good success, the stations all being of low power, and situated in centres of relatively dense population.

In 1929 and 1930 Bell Telephone Laboratories undertook extensive experimental work in connection with synchronized broadcasting, and commercial equipment was designed to synchronize two 1-kw. stations 150 miles apart. The stations had not previously operated simultaneously. Independent crystal-controlled oscillators were used, capable of maintaining their frequency within about 5 cycles over long periods. At a mid-point between the stations a monitoring receiver was located, and the beat frequency from the two carriers was transmitted back to one station.

At this point the frequency of the crystal-controlled oscillator was shifted a small amount by the operator, the frequency difference being maintained in this way at less than 1/10 cycle. This is the so-called radio-frequency monitoring system.

With this arrangement it was found that the normal service area of each station was maintained, and the night-time reception was improved at points 100 miles or more distant from either station, where amplitude and selective fading had previously been severe.

More recently rather elaborate automatic synchronizing equipment has been developed by Bell Telephone Laboratories. A diagram of one terminal of the equipment is shown in Fig. 10. Each synchronized station (of which there may be a number on one frequency) is equipped with two quartz crystal-controlled oscillators, one a spare. These oscillators are capable of maintaining their frequency within a few cycles over long periods. From a central location an oscillator of quite high frequency stability transmits 4,000-cycle current over telephone lines to each station. At this point, by a process of frequency multiplication and modulation two currents are obtained, each of

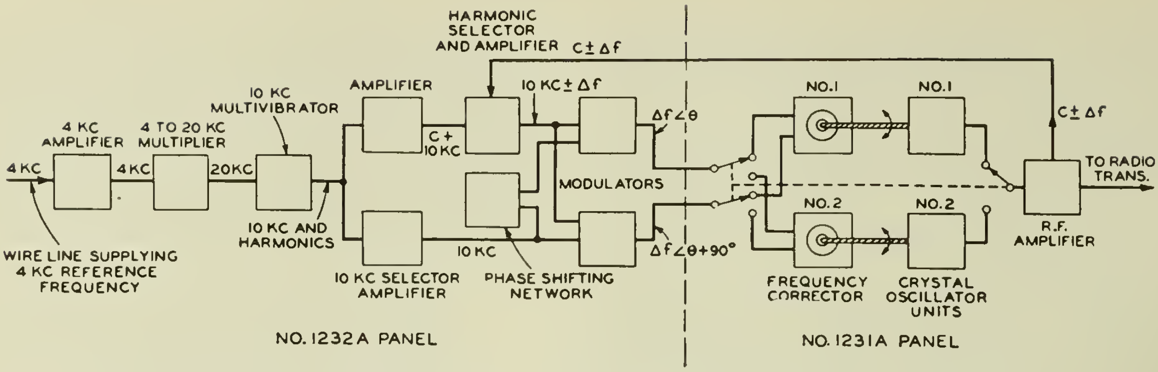

Fig. 10—Diagram of Synchronizing System for Common Frequency Broadcasting.

frequency ΔF equal to the difference of $C + \Delta F$, the frequency of the local crystal-oscillator, and the correct carrier frequency, C, as derived from the 4,000-cycle oscillator. One current, however, is advanced 90 degrees in phase ahead of the other. The two-phase current resulting from the combination is applied to a motor unit which revolves a variable condenser giving small variations in the crystal-controlled carrier oscillator. The motor unit tends to revolve until the carrier oscillator is brought into synchronism with the carrier frequency which would be derived from the 4,000-cycle transmission. Thus the equipment at each station automatically adjusts the carrier frequency to a fixed multiple of the driving oscillator frequency. In extended trials this equipment has been shown to be capable of maintaining the frequencies of two stations within about 1/10 cycle over a period of several months. It is interesting to note that even in case the control circuit is disrupted between the master oscillator and a station, due to the high stability of the local oscillator the carrier frequency will drift by only a very small amount over the time of any probable interruption of the service. This system has been called the wire-line reference method for securing synchronism.

It seems probable that from the point of view of accuracy of synchronization and reliability this equipment is close to the ultimate.

A third method of synchronization which has received some attention is that of generating a carrier wave and modulating it at a central point. High-frequency transmission lines, perhaps two-conductor concentric cables, carry the modulated wave to the transmitter locations where the wave is amplified through a series of stages, and finally radiated by an antenna. This system would of course give accurate synchronization, but the problems associated with the high-frequency transmission lines appear to be nearly insoluble at present.

Acknowledgment

The present writer is indebted to the Northern Electric Company, Limited, for permission to publish this study. Figure 3 has been taken from ref. (4) and Figs. 5, 6, and 7 from ref. (9).

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The following list of references to the periodical literature is not complete, but comprises all the sources which were used in the preparation of this paper, as well as a few which were not available, but whose chief conclusions were known. An attempt has been made to classify these references by subject, but this is of necessity somewhat indefinite, as many of the papers deal with several aspects of the subject.

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La Route Moderne

Avec quelques renseignements sur le système routier de la province de Québec

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Causerie donnée à la Section de Québec de l'"Engineering Institute of Canada" le 18 février 1935.

Les voies de communication et les modes de transport se sont adaptés comme toute autre chose aux besoins de leur temps.

Depuis les jours lointains des chariots à deux roues traînés par des bœufs à demi-sauvages, et des galères à double rangée de rames, le monde a vu se succéder l'âge du carrosse, de la diligence et de l'omnibus, des navires à voile, des bateaux à vapeur, des chemins de fer, des tramways électriques et enfin de l'automobile et de l'aéroplane.

La machine à vapeur fut la merveille de son temps. Son apparition a mis en branle des centaines de cerveaux qui s'ingénièrent non seulement à la perfectionner, mais aussi et surtout à l'appliquer au transport au moyen d'inventions corollaires comme le bateau à hélice et le wagon sur rail de fer, etc. On vit alors les continents se couvrir d'un treillis de voies ferrées et les mers s'émailler de vaisseaux toujours plus lourds et plus rapides. Ce fut sur terre l'âge d'or de la locomotive et du rail. Les grandes compagnies ferroviaires régnaient en souverains dans le monde du transport.

Un petit incident, l'invention du moteur à explosion, devait terrasser le colosse d'un siècle.

Les milliers de wagons qui dorment sur des voies principales désaffectés, les centaines de locomotives qui encombrent les abords des usines de chemin de fer, les démarches répétées de compagnie pour essayer de vendre aux divers départements ou commissions de voirie, l'assiette de voies qu'on projette d'abandonner, les vieux rails à demi-recouverts d'asphalte qu'on aperçoit encore dans les rues des petites villes comme un vestige d'un autre âge, sont autant de témoignages irréfutables de la révolution opérée dans le domaine du transport depuis une vingtaine d'années.

Il avait semblé tout d'abord que le moteur à essence arrivait comme un adjoint pour combler une lacune dans le système de transport établi. Sa légèreté et son adaptabilité aux petits véhicules le désignaient clairement comme agent de propulsion pour transport rapide à courte portée. Il devait former les rameaux de cet arbre dont le lourd train à vapeur constitue le tronc rigide et les grosses branches. Eh bien non!... C'est un enfant qui a grandi vite, et qui déjà se dégage de la tutelle qui croyait le tenir indéfiniment en sujétion. Il est devenu un arbre par lui-même. Il a engendré un système de transport sur terre, indépendant des autres, sans mentionner son frère cadet qui s'appelle le transport aérien. De véritables trains circulent maintenant sur certaines de nos routes durant les douze mois de l'année, et cela vingt-quatre heures par jour.

Les trains automobiles d'aujourd'hui pèsent 60,000 livres, avec la souplesse qui donne l'avantage de porter jusqu'à la porte de l'acheteur, la marchandise transportée.

Que sera l'avenir? L'examen du passé et des conditions présentes le font entrevoir. Depuis trente ans on construit des routes modernes. Certaines d'entre elles ont été reconstruites deux fois depuis ce temps, et combien pitoyable apparaît l'ancienne à côté de la nouvelle. Celles qui faisaient l'enchantement des voyageurs de leur temps, sont devenues un sujet de critique ou de risée. On s'indigne et on peste encore contre les chemins poussiéreux sans songer que nos premières routes ne permettaient pas assez de vitesse pour faire de la poussière. Il y a dix ans passés, nos rapports de voirie décoraient la province de Québec du titre pompeux de "Good roads province". Il faut voir comment figurent aujourd'hui ces bons chemins de la première heure comparés aux auto-routes qu'on construit en Europe et aux "super-highways" qu'on voit aux Etats-Unis. Il suffit de lire les publications étrangères et les rapports des congrès de la route pour constater que dans tous les pays, aussi bien en Europe qu'en Amérique, les procédés de construction et les données qui servent de base aux "standards" ont une vie éphémère. Les projets de quelque importance sont souvent modifiés et remodelés au cours de leur exécution au point d'être méconnaissables. Bien des ingénieurs de voirie ont vu tomber leurs illusions lorsqu'après un travail patient et prolongé, ils avaient cru avoir fait œuvre durable dans la préparation des devis généraux pour la construction des routes.

Si nous demandons aux états américains une copie de leurs devis, ils nous répondent: "under revision". Les auteurs qui se sont efforcés d'établir des règles fondamentales et de tracer des directives générales basées sur les conventions adoptées par les congrès internationaux ou autres, pour la construction des routes, se voient continuellement acculés à la nécessité de rééditer leurs ouvrages.

L'Europe, le foyer reconnu de la science et de la civilisation est, comme les jeunes pays d'Amérique, en pleine période de développement et d'expérimentation dans ce domaine. Il est très intéressant de constater que les vieux pays sont en face des mêmes problèmes et des mêmes difficultés que nous avons à envisager dans notre province. La question des pavages antidérapants est étudiée, mais n'est pas résolue. On n'est pas encore fixé sur les composés asphaltiques les plus avantageux, ni sur la possibilité d'émulsifier les goudrons, ce qui serait un avantage considérable dans un pays comme l'Angleterre. Les changements de tracés pour redresser et élargir les routes, dans des limites raisonnables de dépenses, en évitant les agglomérations des villages et des petites villes, rencontrent des protestations tout comme dans la province de Québec.

Les lois régissant les procédures pour expropriations, déplacement de bâtisses et paiements d'indemnités ont été, encore récemment, en France, l'objet d'amendements importants pour simplifier les procédés en usage et réduire le coût de l'établissement des routes sur de nouveaux tracés.

Cependant, l'étude de tous ces problèmes n'empêche pas les européens d'aller de l'avant. Les "auto-strade" en Italie et les auto-routes en France et en Allemagne rivalisent avec les "super-highways" des Etats-Unis. Ces grandes artères modernes sont destinées exclusivement aux véhicules moteurs, sans limite de vitesse. Les croissements à niveau sont éliminés par des passages inférieurs et supérieurs avec raccordements sans virage à gauche, ou améliorés au moyen d'intersections circulaires que les américains appellent "traffic circles," de manière à réduire les dangers d'accidents.

On projette actuellement un système d'auto-routes pour les sorties de Paris, composé de cinq grandes artères radiales, raccordées par une route de ceinture encerclant la ville à une distance de vingt kilomètres du centre; et l'auteur de l'article de la Revue Générale des Routes qui décrit cet immense projet ajoute: "Paris aura enfin des sorties convenables," tout comme nous pourrions dire si les projets dont nous avons commencé l'étude l'été dernier s'exécutent: "Québec aura bientôt des sorties dignes d'une grande ville."

Le programme des auto-routes dans la banlieue de Paris comporte des données ultra-modernes: — pentes et rampes de pas plus de 5 pour cent rayons de courbure de mille mètres, largeur d'emprise de 70 à 100 mètres, avec chaussée double, pour circulation à sens unique d'une largeur de 9 mètres pour chaque voie, flanquée d'une voie latérale de desserte également de 9 mètres de largeur. Les trois voies seront séparées par des terre-pleins plantés d'arbres et d'arbustes. Les pavages seront le béton de ciment, le

Fig. 1—Province de Québec Route 1—Montréal-Sherbrooke. Section du lac Orford.

pavage mosaïque ou bien le revêtement noir épais, reconnus comme les plus aptes à porter une circulation intense. Elles ne traverseront à niveau aucune autre voie et les raccordements peu nombreux seront du système "grade separation." Elles seront éclairées abondamment.

Les trois principales artères de ce réseau auront une longueur totale de 90 kilomètres et coûteront 500 millions de francs.

On voit que si la France fut devancée par l'Italie, avec ses "auto-strade," elle est bien résolue à reprendre le terrain perdu. Inutile de dire que l'Angleterre et l'Allemagne progressent dans le même sens pour l'aménagement de leurs réseaux routiers.

Si nous retraversons la mer pour voir ce qui se passe chez nos plus proches voisins, nous constatons que les "super-highways" sont un fait accompli depuis plusieurs années, et les récents hauts-faits des Américains dans ce domaine dépassent nettement ce qu'il y a de plus remarquable en Europe. Je suggère à ceux qui en auront l'occasion, de visiter les dernières créations de l'état de New-Jersey pour les sorties de New-York vers l'ouest. Le chemin d'approche du tunnel Holland est un colossale monument qui émerveille les visiteurs, sinon par sa beauté, du moins par sa masse. Les ingénieuses combinaisons de raccordements avec les voies transversales et les imposantes dimensions de ce chemin élevé sur des milles de longueur contournant la ville de Newark, passant au-dessus d'une multitude de voies ferrées, en font un chef-d'œuvre dans son genre.

L'approche du pont Georges Washington est une autre production épatante du génie américain. Ce tronçon reçoit le trafic de quatre grandes artères venant du nord, de l'ouest et du sud pour donner accès à New-York, à la plus grande partie des quelques deux cent mille personnes qui entrent et sortent de la ville chaque jour, sans compter le va-et-vient du trafic local.

Une chose très remarquable dans le réseau du New-Jersey, c'est la diversité des formes d'intersections. Chaque cas semble être un problème spécial, parfois très compliqué. Aucune grande artère n'est traversée à niveau par une autre voie, et le genre d'intersections varie non seulement selon l'importance des routes, mais aussi selon la topographie des lieux. L'intersection circulaire "traffic circle" est la plus simple et la plus économique. Toute voiture qui s'engage dans le cercle tourne à droite. Il en résulte que la circulation sur le cercle même se fait toujours en tournant à gauche et par conséquent c'est "one way." Ce système a l'inconvénient de ralentir la circulation, mais élimine pratiquement tout danger de collision. Il occasionne, quelquefois, des accidents par des voitures qui vont se buter sur l'îlot au centre du cercle.

L'intersection "clover leaf" paraît être devenue "standard" mais n'est pas fréquemment employée à cause de son coût excessif et de l'espace considérable requis pour l'établir. Il permet de franchir le croisement à toute vitesse. Le passage d'une route à l'autre en tournant à droite est simple, mais pour aller à gauche, il faut faire une boucle complète dans un virage à droite et en passant du niveau bas au niveau élevé ou vice-versa. Il est également remarquable que certains croisements ne comportent aucun raccordement entre les deux routes, d'autres sont pourvues d'un virage dans un seul sens. Nos amis, les Américains, ont-ils des formules basées sur l'intensité de la circulation pour déterminer ce qu'il y a à faire dans chaque cas? Il n'y aurait pas lieu d'en être surpris si on considère l'armée d'ingénieurs qu'ils emploient. Le seul état de New-York occupe onze cents ingénieurs pour le service de la voirie et des canaux.

Le comté de Wayne dans l'état de Michigan a aussi un système de "super-highways," très avancé. Les grandes artères qui rayonnent en lignes droites de la ville de Détroit, peuvent desservir un trafic énorme, probablement beaucoup plus considérable que celui qu'elles portent actuellement. La largeur d'emprise de ces routes est de 204 pieds. La chaussée est formée de deux voies bétonnées de 30 à 40 pieds de largeur chacune, séparées par un terre-plein d'environ 75 pieds, orné de plantations diverses. Les croisements sont du genre "grade separation." Les voies doubles nécessitent deux ponts à chaque intersection et les masses de béton qui entrent dans ces ouvrages sont énormes. Le pays étant très plat, les traverses de voies ferrées se font toujours par des passages supérieurs.

Une tournée d'inspection faite l'été dernier sur les routes de l'état de New-York, en compagnie des principaux officiers de la commission des chemins, nous a permis de constater une fois de plus, l'esprit pratique des Américains qui savent malgré leurs richesses, faire rendre à chaque dollar employé dans la construction, sa pleine valeur. Leur main-d'œuvre, il faut bien l'admettre, est considérablement supérieure à la nôtre tant au point de vue de l'habileté qu'au point de vue de la rapidité dans l'exécution des travaux.

La construction d'un chemin de première classe pour atteindre le sommet du mont Whiteface, près du lac Placid, en voie de parachèvement, est une entreprise digne de leurs émules du New-Jersey, non pas tant par son envergure que par sa particularité et la fantaisie qui semble l'avoir inspirée.

Cette route de 9 milles de longueur en rampe continue, variant de 4 pour cent, qu'elle est au bas, jusqu'à 10 pour cent vers le sommet, a pour seule fin d'atteindre un point d'observation à 4,600 pieds d'altitude d'où l'œil embrasse un panorama grandiose de montagnes et de lacs. Cette route coûtera un million. Elle est construite avec des fonds souscrits librement pour l'érection d'un monument aux vétérans de la guerre. Environ la moitié du parcours est taillée dans le roc vif sur une pente escarpée, avec mur de soutènement en grosses pierres atteignant jusqu'à 80 pieds de hauteur. Elle comporte des lacets remarquables dont l'un appelé "hair pin" permet de voir la route cent pieds en dessous de soi à une distance horizontale de cent pieds.

D'une manière générale dans l'état de New-York, les grandes routes qu'on reconstruit sont tracées à neuf avec des profils et des courbes d'un "standard" beaucoup plus élevé que les anciennes. La largeur des nouvelles chaussées en rase campagne, varie de 20 à 30 pieds et le pavage est exclusivement de béton armé.

Les routes de seconde classe sont améliorées sans modifier les tracés, ni les profils. On utilise comme fondation les vieux macadams qui les recouvrent en les élargissant à 18 ou 20 pieds. Cette fondation est ensuite recouverte d'un revêtement bitumineux genre "low cost."

Le réseau de l'état a une longueur totale de 14,000 milles de grandes routes, entretenues au coût de 8 millions par année. La dépense de réfection ou de reconstruction se chiffre à 35 millions par année. Ces montants représentent environ la moitié des revenus annuels des véhicules automobiles qui s'élèvent à environ 85 millions.

Laissons là, si vous le voulez bien, ces gros chiffres et revenons dans notre pays. La modeste histoire de notre voirie provinciale n'est pas sans intérêts. Les développements atteints et les "standards" établis pour le réaménagement de nos grandes routes sont les fruits d'un travail persévérant et d'efforts soutenus durant plusieurs années.

Il y a quelque quinze ans, on trouvait fort extravagant les quelques terrassements que nous faisions pour corriger les profils. Quant aux alignements et courbes, il fallait se contenter de l'espace compris entre les clôtures.

Cependant, à mesure que les automobiles et les camions pénétraient dans les milieux ruraux, la mentalité de nos populations évoluait dans le sens du progrès et les propriétaires de véhicules automobiles se faisaient nos collaborateurs sur ce point. Leurs suggestions ont parfois dépassé la manière de voir des ingénieurs sur l'élargissement, le redressement et le reprofilage des routes. Les clubs d'automobilistes ont aussi agi dans le même sens, mais leurs observations et suggestions sont presque toujours d'un caractère général et plutôt vague. Les autres corps publics, chambres de commerce, et corporations municipales, grandes et petites, ne semblent pas s'être intéressés considérablement aux questions d'améliorations modernes des routes. Les conseils municipaux des campagnes font bien des représentations pour obtenir dans leurs limites des améliorations sans beaucoup d'envergure, à l'ancienne façon et en fonctions des intérêts purement locaux. Et, il faut le dire, souvent en opposition avec l'intérêt public et les projets des ingénieurs, surtout lorsqu'il s'agit de changement de tracés.

Evidemment, l'exemple des pays voisins a fait beaucoup pour amener l'opinion publique à accepter les conditions nouvelles et à ne pas se scandaliser des "standards" proposés par les ingénieurs.

C'était l'automobile qui transformait les idées avant de transformer les routes. Force nous est d'admettre que dans de telles conditions, nous suivons nos voisins au lieu de les précéder ou de marcher de front avec eux. A tout prendre c'est peut-être aussi bien qu'il en soit ainsi au moins pour quelque temps. Nous savons combien il est difficile de prévoir avec quelques précisions le développement des problèmes de voirie et du transport routier en général, pour saisir la nécessité qu'il y a d'avancer prudemment sur ce terrain. Les ressources très limitées de notre province, comparativement aux états de l'union américaine, les rigueurs de notre climat qui paralysent la circulation routière durant quatre ou cinq mois de l'année en réduisant d'autant le rendement de nos routes et leur valeur économique, sont des faits qu'il ne faut pas perdre de vue dans l'étude de nos problèmes de voirie. L'important, c'est de prévoir suffisamment les besoins futurs du trafic routier pour établir nos plans et marcher sur les données qui ne nous obligeront pas à des démolitions ruineuses lorsque le moment sera venu de recourir à des nouveaux revêtements de surface et à des pavages plus forts et plus dispendieux. Il importe donc d'étudier soigneusement les tracés et les profils et d'établir l'assiette des routes en rapport avec les besoins du trafic pour une période de temps donnée, en se basant sur les probabilités de développement de la circulation routière. C'est là que se trouve le point critique. Où vont s'arrêter la vitesse, les dimensions et le poids des convois, et surtout l'accaparement du transport de toute sorte par l'automobile, le camion et l'autobus? Les ingénieurs de tous pays se fatiguent les méninges à trouver une solution rationnelle à ce problème! En fait sur la question des tracés et des profils, il n'y a pas de différences considérables entre nos devis et ceux des états américains.

Fig. 2—Province de Québec Route 11a—Montréal-St-Agathe. Près de Ste-Rose.

Notre réseau de grandes routes d'une longueur totale de 5,585 milles est divisé pour fin de reconstruction en quatre classes — Nos "standards" pour chaque classe fixe la largeur entre clôture ou largeur d'emprise, la largeur entre fossés ou largeur de la plate-forme, largeur du pavage, rayon de courbure minimum, et distance de visibilité, tant dans les courbes verticales que dans les courbes horizontales. Nous n'avons pas de rampes maxima, mais nous tâchons de ne pas dépasser sept pour cent, sauf dans les régions de montagnes où nous admettons des rampes beaucoup plus fortes. Le devers de la plate-forme dans les virages est le même pour toutes les classes et varie en proportion du degré de courbure, à partir de 2°. Il augmente de $\frac{1}{8}$ de pouce pour chaque degré de courbure additionnel jusqu'à 9° où il est de 1″ par pied de largeur de chaussée. C'est le devers maximum qu'on applique à toute courbe au-delà de 9°.

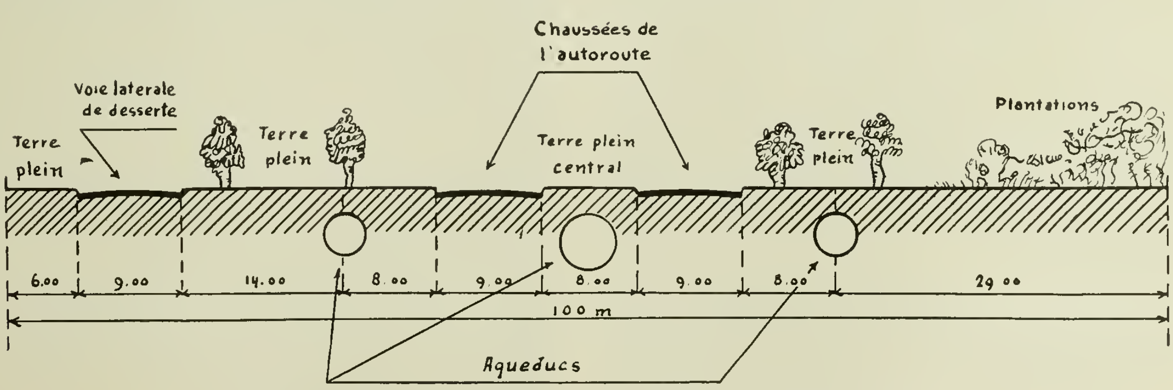

Fig. 3—Profil Type de l'Autoroute du Sud. Banlieue de Paris.

Le degré de courbure maximum est de 11°-30′ correspondant à un rayon de 500 pieds. Il s'applique aux classes C et D, qui comprennent les routes de moindre importance. Pour les classes A et B, qui constituent nos grandes artères, les degrés maximum de courbure sont respectivement de 6° et 8° et la distance de visibilité de 500 pieds. La longueur maximum des courbes verticales et horizontales est de 500 pieds.

La largeur de la chaussée varie de 18 pieds à 30 pieds, et la largeur d'emprise de 50 pieds à 90 pieds.

Durant les dernières années nous avons reconstruit sur ces données environ 103 milles de routes.

Fig. 4—Province de Québec Route 4—Montréal-Malone. Près de Montréal.

Notre climat avec ses pluies abondantes l'automne, et ses fortes gelées l'hiver, introduit dans nos problèmes routiers des difficultés qu'on trouve rarement ailleurs.

Après de nombreuses expériences et de longues observations nous avons trouvé que le meilleur remède contre les dommages causés par la gelée est un coussin de sable placé en-dessous de la fondation. La plupart de nos dernières constructions sont faites d'après cette méthode.

Les fondations sont faites en pierre ou en gravier et quelquefois une combinaison des deux. Une couche de gravier de 12″ durcie ou 10″ de pierre roulée et partiellement liée constitue une fondation suffisante pour les charges admises à circuler sur nos routes. La vieille méthode du macadam à l'eau comme revêtement de surface est abandonnée. On se contente de faire durer autant que possible les surfaces macadamisées en les recouvrant périodiquement de tapis bitumineux. Les revêtements modernes sont en macadam bitumineux, béton bitumineux ou béton de ciment. Nous avons commencé récemment un genre de revêtement mince de goudron, sur les surfaces gravelées. C'est une mesure temporaire pour faire disparaitre la poussière durant l'été et empêcher la boue de se former à la surface durant la période pluvieuse de l'automne. Ce mode de revêtement, peu dispendieux, à en outre l'avantage de supprimer les apports de gravier continuels qu'il faut faire pour maintenir les surfaces gravelées en bon ordre, et de ce fait, nous dispensera dans un avenir prochain d'une quantité considérable de machineries employées actuellement au grattage et au transport des matériaux de rechargement. Elle supprimera également, en attendant qu'on puisse construire des pavages plus durables, un danger d'un nouveau genre occasionné par les petites pierres volantes du gravier concassé.

Les revêtements bitumineux qu'on a appelé permanents ou semi-permanents, mais qui n'ont rien de permanent, varient en épaisseur de 2″ à 4″. Ils comprennent 1o. — Les macadams bitumineux formés d'une couche de pierre de 4″ d'épaisseur qu'on enrobe par simple pénétration d'un liant bitumineux quelconque. 2o. — Les bétons bitumineux qu'on nomme ainsi par analogie avec les bétons de ciment hydrauliques, parce que le mélange des agrégats et des ciments bitumineux se fait mécaniquement.

Il y a un nombre considérable de types, dont la plupart sont brevetés dans notre pays. Par ordre d'ancienneté on les nomme: Amiésite, Macurban, Colprovia, Creomix, Macasphalt, Coldsphalt, et comme Benjamin de cette famille, le Gécomac qui a fait son apparition l'été dernier.

Tous ces produits ont été généralement appliqués pour des revêtements de 4″ d'épaisseur. On a vite constaté cependant qu'ils étaient trop dispendieux pour le pavage des chemins ruraux, et aujourd'hui on adopte un peu partout des types de pavage dits économiques (low cost), de 2″ à 3″ d'épaisseur tels que le "retread," pierre et bitume mélangés sur le chemin, le "gravel mulch", mélange de gravier et bitume, et d'autres types de mélanges à pourcentage réduits de liant bitumineux qui ne coûtent pas beaucoup plus cher que les anciens macadams, et qui donnent de très bons résultats sous un trafic moyen.

Enfin ce sont les pavages en béton de ciment hydraulique qui sont les seuls à peu près permanents et encore faut-il qu'ils soient faits avec les meilleurs matériaux, et d'après les méthodes modernes de fabrication du béton. Nous pouvons dire sans exagération que ces nouvelles méthodes ont augmenté de 100 pour cent la valeur des pavages en béton. Je ne tenterai pas de décrire ces méthodes. J'indiquerai toutefois les points saillants des récents perfectionnements dans ce domaine. Le contrôle de la qualité des matériaux et des travaux se fait entièrement sur place et tous les essais sont faits dans un laboratoire temporaire établi sur le chantier. Dans ce laboratoire tous les matérieux sont soumis à l'analyse et aux épreuves ordinaires, granulométrie, contenu d'humidité, pourcentage de terre ou de matières végétales dans les sables; résistance à la traction et à la tension ainsi que le dosage des matérieux basé sur la granulométrie. Le laboratoire est muni des instruments et appareils modernes, tels que la presse pneumatique d'une capacité de 100,000 livres pour briser les cylindres dans les essais à la compression, l'appareil pour casser les briquettes et l'appareil pour casser les poutres, balance de précision, sécheur, bain pour le curing, etc. Sur le chantier, le dosage des matériaux se fait par balances automatiques pour le sable, la pierre et l'eau. Ces balances sont surveillées par un employé du gouvernement et ajustées aussi souvent qu'il est nécessaire selon la graduation de la pierre, la granulométrie du sable et son contenu d'humidité.

La rupture des cylindres est faite à sept jours et à vingt-huit jours. Pour le "curing" on procède encore d'après l'ancienne méthode de recouvrement et d'arrosages répétés. La méthode qui consiste à appliquer du chlorure de calcium à la surface pour capter l'humidité de l'air ne semble pas devoir se généraliser. Par contre l'application d'une huile asphaltique légère après la prise du béton pour retenir l'humidité dans la masse, prend de la vogue aux Etats-Unis depuis une couple d'années. L'usage des formes en acier et l'appareil à comprimer (qui supprime le dommage) permet d'obtenir un profil parfait et une compacité du béton très remarquable, sans danger de ségrégation des matériaux. Des gabarits métalliques très rigides que l'on fait mouvoir sur les coffrages en acier assurent la régularité de l'infrastructure. Malgré ces précautions, l'épaisseur du pavage est vérifiée après coup en mesurant les carottes obtenues en perçant le pavage avec une foreuse spéciale. Des joints transversaux et longitudinaux sont ménagés au besoin pour tenir compte des retraits et expansions dus aux écarts de température.

La tendance actuelle est d'armer tous les pavages en béton et sur ce point les devis sont variés sans limites. Les uns placent l'armature près du fond, les autres, près de la surface. Le poids par cent pieds carrés se tient à peu près entre 40 livres et 82 livres.

Nous avons actuellement 16,000 milles de chemin améliorés dont 5,585 milles classés comme grandes routes. Inutile de dire que ces grandes routes ne sont pas toutes des routes modernes. Tous ces chemins améliorés sont entretenus exclusivement par le département de la voirie au coût d'environ 3½ millions par année.

Nous avons dans la province de Québec, 174 milles de macadam bitumineux, 586 milles de pavage en béton bitumineux et 179 milles de pavage en béton de ciment. Le coût de ces pavages est de l'ordre de $20,000 du mille, et, si on ajoute les fondations, les travaux préliminaires et les acquisitions de terrain, nous arrivons à environ $40,000 du mille. L'introduction des pavages genre "low cost" nous permettra de réduire ce coût d'environ $12,000 du mille, tout en conservant un revêtement de surface capable de porter un trafic moyen d'une façon satisfaisante. Cependant, à cause de la grande longueur de notre réseau, nous ne pouvons espérer de paver, même avec ce système de pavage économique, la plupart des routes dans quelques années, c'est pourquoi nous avons entrepris un programme de revêtements minces de l'ordre de $2,000 du mille qui pourra s'exécuter à l'allure de 250 milles par année.

Nous espérons ainsi, tout en continuant notre programme de pavage, donner à nos automobilistes et aux touristes étrangers, des routes propres et sans poussière dans un avenir rapproché.

The Modern Highway

With Notes on the Highway System of the Province of Quebec

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(*Translation*)

Means of communication and methods of transportation, like many other things, have become adapted to the requirements of the times. Since the early days of two-wheel carts drawn by half-wild oxen, and galleys propelled by two tiers of oars, the world has seen successively the eras of the horse-drawn carriage, the stage coach and the omnibus, the sailing vessel, the steamship, the railway, the electric tramway and finally the day of the automobile and the aeroplane.

The steam engine was the marvel of its age. Its appearance aroused activity in hundreds of brains, whose ingenuity was taxed not only to perfect it, but also more especially to apply it to transportation by the aid of auxiliary inventions like the screw steamer and the railway locomotive. Continents were covered by a network of railways, and the seas dotted with ships ever becoming larger and faster. On land this was the golden age of the locomotive and railway. The great railway companies ruled like emperors in the world of transportation. Finally, one small incident, the invention of the internal combustion engine, caused the collapse of this mighty empire.

Thousands of cars lying idle on disused tracks, hundreds of locomotives encumbering the neighbourhood of railway shops, repeated attempts by the companies to sell to various government departments or highway commissions the railway systems which they are anxious to abandon, old rails, half covered with asphalt which may still be seen in the streets of small towns, like relics of a former age, all constitute irrefutable evidence of the revolution which has taken place in the domain of transportation during the last twenty years.

At first it was thought that the gasoline motor would merely serve to fill a gap in the then established systems of transportation. Its lightness and adaptability to small vehicles clearly indicated it as a means of propulsion for rapid transport over short distances. It was to form a twig of the big tree of which the heavy steam train constituted the rigid trunk and the main branches. But no—it has proved to be a fast-growing child, which is already freeing itself from the tutelage which was to hold it indefinitely in subjection. It has become a tree itself. It has brought about a system of land transportation independent of all others, to say nothing of its younger brother, the aeroplane. Motor trains now operate twenty-four hours a day and twelve months of the year on many of our roads. Motor trains of to-day weigh 60,000 pounds, and have a flexibility which gives them the advantage of carrying supplies right up to the purchaser's door.

What does the future hold in store? A survey of the past and present conditions will indicate this. For the past thirty years we have been improving roads. Some of them have been built twice during this period, and how insignificant the old roads appear beside modern highways. Roads which were the delight of travellers in their day have now become a subject for criticism or laughter. People grumble about dusty roads without thinking that our early highways did not allow of sufficient speed to raise dust. Ten years ago our Highway Department's report bestowed on Quebec the imposing title of "The Good Roads Province." But see how these "good roads" of early days compare with the auto-roads which have been constructed in Europe and the super-highways to be seen in the United States. It is sufficient to read foreign publications and the reports of highway congresses, to note that in all countries in Europe as well as in America, methods of construction and conceptions serving as bases for standards are short lived.

Schemes of any importance are often so modified and remodelled during the course of their execution as to be hardly recognizable. Many highway engineers have seen their illusions vanish, when, after lengthy and painstaking work, they believed that they had accomplished something permanent in the preparation of general specifications for highway construction.

If we ask for copies of highway specifications from various states, they inform us that they are "under revision." Authors who have striven to establish fundamental rules and draw up general directions based on agreements adopted by international congresses for highway construction, see themselves continually obliged to revise their work.

Europe, the acknowledged home of science and civilization, is like the younger countries of America, in the midst of a period of development and experimentation in this domain. It is most interesting to note that the older countries are facing the same problems and the same difficulties that we have to confront in this province. The question of non-skid surfaces has been studied but not yet solved. Nothing has been decided as to the most advantageous asphaltic compounds, or as to the possibility of successfully emulsifying tars, a matter which would possess considerable advantage for a country like England. Proposed changes of location for widening and straightening highways, within reasonable limits of expenditure, while avoiding the congestion of small towns and villages, meet with objections in Europe, just as they do in the province of Quebec.

Important changes were made recently in France in the laws governing the procedure for expropriation, removal of buildings, and payment of damages, with the object of simplifying present procedure and lowering the cost of constructing highways on new locations.

Nevertheless, the study of all these problems has not prevented Europe from forging ahead. Italy's "auto strade" and the "auto routes" in France and Germany rival the super-highways of the United States. These great modern arteries are exclusively reserved for motor vehicles, with no speed limits. Level crossings have been eliminated by overhead or underground passages and junctions with no left turn, or improved by means of circular intersections, which the Americans call "traffic circles," so as to reduce the danger of accidents.

A system of auto roads for the exits from Paris, now contemplated, will consist of five great arteries connected by a belt highway encircling the city at a distance of twelve miles from the centre, and the author of an article in the "Revue Générale des Routes" who gives a general description of this immense scheme, remarks that "Paris will at last have suitable exits," just as we might say, if our projects are carried through "Quebec will soon have exits worthy of a great city."

The programme of auto-routes on the outskirts of Paris embodies ultra-modern data:—grades not more than 5 per cent, curves with a radius of 3,300 feet, right-of-way of between 215 and 330 feet, with double roadway, for one-way traffic, each roadway being 30 feet wide, flanked by a lateral service roadway, also 30 feet wide. The three roadways will be separated by platforms planted with trees and shrubs. The pavement will be cement concrete, blocks, or asphalt concrete of a high type, the most suitable to stand up under heavy traffic. There will be no level crossings of any kind on these roads, and the few junctions will be on the grade separation system. They will be brilliantly lighted.

The three main arteries of this network will have a total length of 45 miles, and will cost 500,000,000 francs.

It will thus easily be seen that if France was preceded by Italy, with its "auto-strade," it is determined to regain the lost ground. Actually both England and Germany are progressing along the same lines for the development of their highway systems.

If we recross the ocean, to see what is going on among our closest neighbours, we find that super-highways have been an accomplished fact for several years, and that recent American exploits in this domain definitely surpass the most remarkable achievements in Europe. Those having an opportunity should visit the latest achievements of the state of New Jersey for the exits from New York to the west. The approach to the Holland Tunnel is a colossal monument which amazes visitors, if not by its beauty, at least by its size. The ingenious methods of effecting junctions with transverse roads and the imposing dimensions of the elevated roadway, which extends for miles, by-passing the city of Newark, and passing over a multitude of railways, make it a masterpiece of its kind.

The approach to the George Washington bridge is another amazing production of American genius. This bridge handles traffic from four main arteries leading from the north, the south and the west, to provide access to New York for the majority of some two hundred thousand people who enter and leave the city each day, without counting local traffic.

A remarkable feature of the New Jersey highway system is the variety of types of intersection. Each case seems to be a special problem, often quite complicated. There are no level crossings on any of the main arteries, and the types of intersection vary not only according to the importance of the highway, but also according to the topography of the district. The circular intersection, known as the "traffic circle," is the simplest and most economical. All cars entering the circle turn to the right. This means that traffic in the circle itself is always turning to the left, and is one-way traffic. This system, while it has the inconvenience of slowing up traffic, practically eliminates all danger of collision. There are, however, accidents now and then when vehicles crash into the island in the centre of the circle.

The "clover leaf" type of intersection seems to have become a standard, but it is not frequently employed, owing to its excessive cost and the large space required to establish it. It permits of crossing the intersection at full speed. Turning to the right from one road to another is simple, but turning to the left necessitates first turning to the right, then making a complete circle and passing from low level to high level, or vice-versa. It is also remarkable that certain intersections fail to provide any connection between two roads, while others allow for a one-way turn only. Have our American friends formulæ, based on the intensity of traffic, to determine what is to be done in each case? This would not be surprising if one considers the army of engineers employed. In the state of New York alone there are eleven hundred engineers for the Highways and Canals Service.

Wayne county, in the state of Michigan, also has a very advanced system of super-highways. Main arteries which radiate in straight lines from the city of Detroit, can accommodate enormous traffic, probably much more than they are called upon to handle at present. The right-of-way on these highways is 204 feet wide. The roadway consists of two concrete lanes, each between 30 and 40 feet wide, separated by a platform about 75 feet wide, planted with ornamental shrubs. Intersections are of the grade separation type. The double roadways necessitate two bridges at each intersection and the masses of concrete which form these works are enormous. The country being flat, all railway crossings are overhead.

A tour of inspection of highways in the state of New York, carried out last summer, in company with the chief officers of the Highways Commission, enabled us again to appreciate the practical spirit of the Americans, who, despite their wealth, know how to get full value for each dollar employed in construction. Their workmanship is undoubtedly superior to our own, whether from the view-point of the skill or the speed shown in the execution of their work.

Fig. 5—Intersection of Route Carrying Traffic for George Washington Bridge and Teaneck Road, Teaneck, N.J.

The construction of a first-class highway to reach the top of Whiteface mountain, near lake Placid, now nearly completed, is an undertaking worthy of their New Jersey rivals, not so much on account of its extent as of its special character and the imagination which seems to have inspired it. This highway is nine miles long, has a grade varying from 4 per cent at the bottom to 10 per cent at the top, and its sole object is to reach an observation point 4,600 feet high, from which there is a magnificent panorama of lakes and mountains. This highway will cost a million dollars. It is being constructed with funds subscribed for the erection of a monument to war veterans. For about one-half of its length it is cut in solid rock on a side hill, with a retaining wall as high as eighty feet in some places, and of heavy masonry. The road includes remarkable bends, one of which, known as the hairpin turn, affords a view of the road one hundred feet below, and a hundred feet away horizontally.

In New York state, in general, the main highways that are being reconstructed are laid out anew with profiles and curves of a much higher standard than those of the old roads. The width of the new pavements in open country varies between 20 and 30 feet, and the surface is of reinforced concrete.

Second class roads are improved without changing their location. Old macadams are used as foundations and the pavements widened to 18 or 20 feet. This foundation is then covered with a low cost bituminous pavement.

The state highway system has a total length of 14,000 miles of main highways, maintained at a cost of $8,000,000 per year. Resurfacing and reconstruction expenditures amount to $35,000,000 per year. These amounts represent approximately one-half of the annual revenue from automobiles, which is about $85,000,000.

Let us leave these huge figures and return to our own country. The modest history of our provincial highways system is not without interest. Developments attained and standards established for the improvement of our main highways are the result of persevering work and sustained efforts during a number of years.

Some fifteen years ago, the few embankments made to improve the profiles of our roads were found rather extravagant, while as regards alignments and curves, we had to be satisfied with the space between fences.

However, as automobiles and trucks penetrated rural districts, the mentality of our population broadened, and automobile owners collaborated with us on this point. Their suggestions were sometimes ahead of the views entertained by engineers on widening, straightening and realigning roads. Automobile clubs also were active along the same lines, but their observations and suggestions are nearly always general in character and somewhat vague. Other public bodies, chambers of commerce, and municipal corporations, both large and small, do not seem to have been greatly interested in the question of modern improvements on highways. Municipal councils in country districts generally ask for improvements within their own limits, but usually disregard the general public interest. They often oppose the plans of engineers, especially when a change in alignment is proposed.

The example of neighbouring countries has evidently done much to induce public opinion to accept the new conditions and the standards proposed by engineers.

The automobile transformed ideas before transforming highways. It must be admitted that, under these conditions, we are not leading nor even keeping pace with our neighbours. On the whole, it is just as well that this be so, at least for a while. Knowing how difficult it is to foresee with any great precision the development of highway problems and of road transportation in general, we realize the necessity of advancing cautiously in this field. The resources of this province, very limited when compared to those of the states in the Union, the severity of our climate, which paralyses highway traffic for four or five months of each year, thus greatly reducing the efficiency of our highways and their economic value, are facts that must not be lost sight of in studying our highway problems. The important point is to foresee the future requirements of highway traffic so as to formulate our plans and proceed along lines which will not lead to ruinous demolitions when the time comes for new and more costly pavements. It is thus important that locations and profiles be carefully studied, and that the highway system be established according to traffic requirements for a stated period, by estimating the probabilities of development in highway traffic. There lies the question mark of the whole situation. Where is the limit to the increase of the speed, size and weight of vehicles, and especially the monopolization of transportation of all kinds by the automobile, truck and autobus? Engineers in all countries are looking for a rational solution to this problem, and the results obtained to date run along the same lines. As a matter of fact, there is very little difference between our specifications and those of the American states, as regards plans and profiles.

Our main highway system, with a total length of 5,585 miles, is divided for construction purposes into four classes. Our standards for each class determine the width between fences or right-of-way, the width between ditches or width of the subgrade, and the width of paving, the minimum radius of curves, and the distance for visibility, both as regards horizontal and vertical curves. We have no maximum grade, but we endeavour not to exceed seven per cent, except in mountainous regions, where steeper grades are used. The banking of the surface at curves is the same for all classes and is proportionate to the degree of curvature. Starting at 2 degrees, it increases ⅛ inch for each additional degree of curvature up to 9 degrees, where it is one inch per foot of width of pavement. This is the maximum amount of banking used on all curves over 9 degrees.

Fig. 6—Traffic Circle at Intersection of two Routes, New Brunswick, N.J.

The maximum curvature is 11 degrees-30 minutes, corresponding to a radius of about 500 feet. It applies in classes C and D, which include the roads of lesser importance. For classes A and B, which constitute the main highways, the maximum degrees of curvature are 6 and 8 degrees respectively, and the distance for visibility 500 feet.

The minimum length of vertical and horizontal curves is 500 feet.

The width of paved surface varies from 18 to 30 feet, and the width of right-of-way from 50 to 90 feet.

During the past few years we have reconstructed about 103 miles of highway according to these specifications.

Our climate, with its abundant rain in the fall, and heavy frost in winter, introduces into our highway problems difficulties that are rarely found elsewhere. After numerous experiments and lengthy observation we have found that one of the best means at our disposal to prevent damage caused by frost action is a sand cushion placed beneath the road foundation. We have applied this method to most of our recent road construction.

Fig. 7—Pulaski Skyway between Newark and Jersey City eliminating Railroad Grade Crossings and Intersecting Streets. Approach Road to Holland Tunnel.

Foundations are of stone or gravel and, in some cases, a combination of both. A layer of compacted gravel, 12 inches thick, or 10 inches of stone, rolled and partly bound, constitutes sufficient foundation for the loads allowed on our highways. The construction of water-bound macadam has been abandoned. Old macadam surfaces are treated with bituminous coatings to make them last as long as possible. Modern pavements are of bituminous macadam, bituminous concrete, or cement concrete. We recently started laying a thin coating of tar on gravelled surfaces. This is a temporary measure to avoid dust during the summer, and prevent surface mud forming during the wet autumn period. This kind of surfacing, low in cost, has the advantage of avoiding continual additions of gravel which are necessary to keep gravelled surfaces in good condition and, as a result, we shall be able to dispose of a considerable part of the machinery used in scraping and transporting resurfacing materials. It will also eliminate, pending construction of more permanent pavements, the new danger arising from small stones of crushed gravel flying in all directions.

Bituminous pavements, called permanent or semi-permanent, but which are neither, vary between 2 and 4 inches in thickness. They include, first: bituminous macadams formed of a layer of stone 4 inches thick, coated with some bituminous binder by simple impregnation; second, bituminous concrete, so-called by analogy with cement concrete, because a mixture of the aggregates and bituminous cements is made mechanically. There are a considerable number of these types, most of which are patented in this country. In order of seniority they are: Amiesite, Macurbam, Colprovia, Creomix, Macasphalt, Coldsphalt and, as the youngest member of the family, Gecomac, which only made its appearance last summer.

All these products were generally applied as surfaces 4 inches thick. It soon became evident, however, that they were too expensive for paving rural roads, and today low cost types of pavement are generally used, between 2 and 3 inches thick, such as the retread type, stone and bitumen mixed on the spot, "gravel mulch," a mixture of gravel and bitumen, and other types of mixtures with reduced percentages of bituminous binder, which do not cost much more than the old macadam pavement, and give very good results under medium traffic.

Finally, there are cement concrete pavements, which are the only ones with a certain degree of permanence, to obtain which they must be built with the best materials, and according to the most modern methods of concrete construction. It may be said without exaggeration that modern methods have increased the value of concrete pavements as much as 100 per cent. I will not attempt to describe them but will merely point out the salient features of recent improvements in this domain. Control of the quality of the materials is carried out on the job and all tests are made in our field laboratories. In these laboratories all materials are tested for grain size, moisture content, percentage of earth and vegetable matter in the sand, resistance to tension and bending, as well as the proportioning of the material. Laboratories are equipped with modern apparatus and instruments, such as a pneumatic press of 100,000 pounds capacity, for breaking cylinders in compression tests, apparatus to break beams and briquettes, precision scales, dryers, curing bath, etc. On the work the proportioning of aggregates is done by automatic scales for sand, stone and water. These scales are inspected by a government employee, and are adjusted as often as becomes necessary, according to the grade of stone and sand and moisture content.

Cylinders are broken at seven days and twenty-eight days. Concrete curing is carried out in the old way by covering and repeated watering. The method consisting of applying calcium chloride to the surface, for the purpose of attracting moisture, does not seem to have become general. On the contrary, application of a light asphaltic oil, after the concrete has set, to retain moisture in the mass, has increased in favour in the United States during the past two years. The use of steel forms and of the finishing machine yields a perfect profile, of remarkable compactness, and without danger of segregation of the aggregates. Rigid metallic templets, sliding on these steel forms, ensure the accuracy of the sub-grade. In addition to these precautions, the thickness of the pavement is verified afterwards by measuring cores obtained from the pavement by means of a special boring machine. Transverse and longitudinal joints are provided wherever necessary, to allow for expansion and contraction.

The present tendency is to reinforce all concrete pavements, and on this point specifications vary extensively. Some prefer the reinforcement near the bottom, while others want it near the surface. The weight per hundred square feet is generally between 40 and 82 pounds.

We have 16,000 miles of improved roads in the province of Quebec at the present time, of which 5,585 miles are classed as main highways. It is unnecessary to point out that these main highways are not all modern roads. All these improved roads are maintained entirely by the Department of Roads, at a cost of approximately $3,500,000 per year.

We have 174 miles of bituminous macadam, 586 miles of bituminous concrete pavement, and 179 miles of cement concrete pavement. The cost of these pavements is around $20,000 per mile, and if we add foundations, preliminary works and purchase of land, we reach a figure of nearly $40,000 per mile. The introduction of low-cost pavements will allow us to reduce this cost by approximately $12,000 per mile and still have a surface capable of carrying a traffic of medium intensity. Because of the great length of our system of main highways, however, we cannot hope to cover the majority of our roads within a few years, even with this economical system of paving. This is the reason for our having undertaken a programme calling for thin surface coatings, at around $2,000 per mile, which can be carried out to the extent of 250 miles per year.

Thus we hope, while continuing our paving programme, to provide, in the near future, a larger mileage of dustless roads for the benefit of our own motorists and for tourists.

Note.—Figs. 5, 6 and 7 are reproduced by courtesy of Mr. E. Donald Sterner, New Jersey State Highway Commissioner.

Electrical Control at Rapide Blanc

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Satisfactory electrical control of apparatus and services is an important feature of modern power-house design. With the large developments of today, the wide interconnection between systems and the tremendous size of the loads carried, the importance of satisfactory voltage and frequency control and above all continuity of service becomes ever more important. In a big modern power-house such as Rapide Blanc, adequate, satisfactory and convenient methods of control play a considerable part in the efficient operation of the station.

As may be imagined, the subject of power-house control, in all the various forms in which it is applied, is a very wide one and the purpose of this article is only to outline in a general way the various classifications, and to run over briefly some of the more interesting types which are in service at Rapide Blanc and the reasons which led to their use.

The subject of power-house electrical control may be divided roughly, into six general classifications:—

1. Power Supply
2. Local Control
3. Remote Control
4. Automatic Control
   (*a*) Protective
   (*b*) Special Service
5. Interlocks
6. Alarm and Indication.

Power Supply

Except for small apparatus such as fans of various sizes, heaters, small motors and so on, almost all power-house equipment is controlled indirectly by means of magnetically operated switches or electrical relays.

In a large development, several different types of electric energy are needed for controlling these magnetic switches and relays. The selection of a.c. or d.c. and voltage depends on the type of equipment controlled, its degree of importance from a service standpoint and also on the method of control used.

Large motors such as gate hoist motors, air compressors, and oil pump motors which run on a.c. are controlled by a.c., since there would be no gain in reliability in using d.c. Motors and apparatus which are automatically controlled by delicate relays or instruments require a low control voltage. Equipment whose reliability of operation is of special importance, such as circuit breakers, field breakers and H.V. motor operated disconnects, must be d.c. operated and controlled from storage batteries. And finally, where miniature keys and lamp indicators are used for remote operation, low voltage d.c. is essential.

At Rapide Blanc the control voltages in use are 550 volts a.c., 110 volts a.c., 250 volts d.c. and 48 volts d.c. and there are also a few applications where 6 volts d.c. is required. Two separate storage batteries provide direct current at 250 volts and 48 volts and dry cells are used for the 6-volt supply.

Local Control

Local control of equipment, while perhaps more common than the various other methods, presents few features of special interest. It is applied in all cases where it is unnecessary or uneconomical to operate from a distance and takes the form of a knife switch, pushbutton operated magnetic contactor, or other well known type of starter. Such features as gate hoists, oil heaters, oil filter pumps and cranes come into this category.

Remote Control

The chief reason for making use of remote control is almost always that of convenience of operation. In times of trouble, when every moment counts in the effort to restore service, a convenient, compact and easily accessible arrangement of meters, control keys and lamp indicators

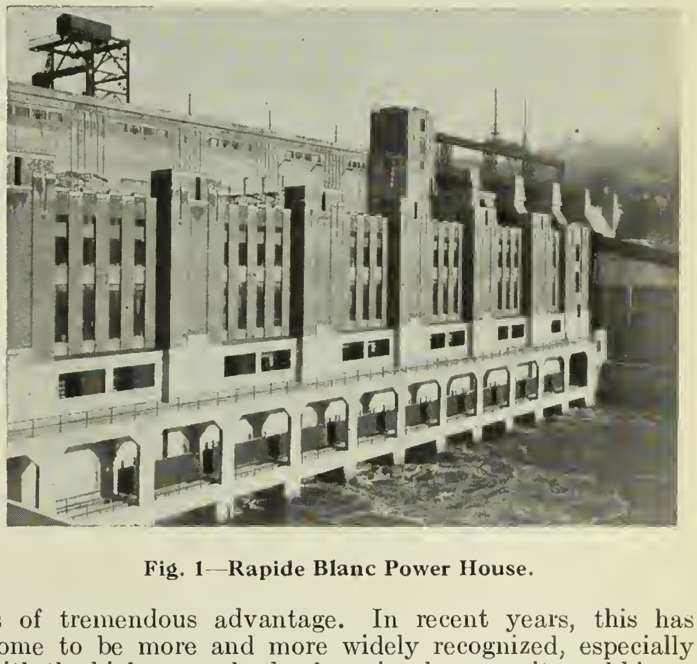

Fig. 1—Rapide Blanc Power House.

is of tremendous advantage. In recent years, this has come to be more and more widely recognized, especially with the higher standards of service, larger units and bigger developments that we have today. In fact, nowadays, a modern station of any size is generally controlled almost entirely from one large isolated room, usually located some distance from the generating machinery, switches and other equipment. As time went by, corresponding improvements in the controlling apparatus itself occurred. Benchboard controllers have been made smaller and better suited to their purpose, benchboard layouts more compact, more accessible, and more comprehensible; miniature meters were developed and finally, for large stations, the miniature type of benchboard and control panel using telephone-type equipment has been evolved and is steadily gaining in favour.

For the Rapide Blanc station, a careful study showed that, in addition to greater operating convenience, considerable economies could be effected by making use of miniature control equipment and consequently wide use has been made of small flush type meters and telephone type keys, push-buttons and indicating lamps.

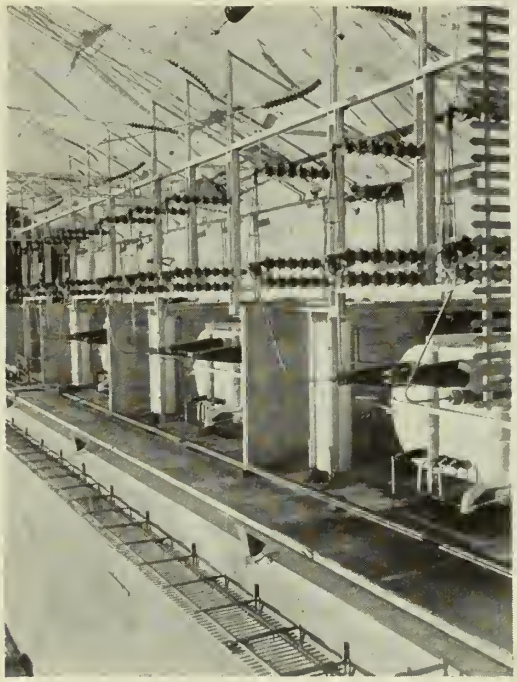

Fig. 2—Rapide Blanc Transformers and 220 kv. Disconnects.

The 48-volt battery, which was mentioned previously, supplies power to the benchboard and auxiliary feeder panel, and the signals and controlling impulses are transmitted at this voltage to interposing relays located adjacent to the equipment concerned. These relays in turn apply current from the main 250-volt battery to the oil circuit breakers, field breakers, motor operated disconnects, governors, rheostats, voltage regulators and similar apparatus.

Inasmuch as the controlling impulses merely operate relays rather than the apparatus itself, very little current is required and therefore, with a given amount of voltage drop, the connecting wires may be quite small. This, in turn, makes possible the use of a few multiconductor cables instead of a great number of conduit runs carrying much heavier wiring.

At Rapide Blanc the controlling impulses, lamp indications, signalling and interlocks for each unit are taken care of by three multiconductor cables made up of No. 16 gauge rubber-covered wires. One 20-conductor cable is for the 220,000-volt motor-operated disconnect, one 60-conductor cable for three 11,000-volt oil circuit breakers and their motor operated disconnects and one 60-conductor cable for the generator control group consisting of field breakers, field rheostat, voltage regulator, signalling equipment and governor adjustment.

Further economy lies in the small panel sizes and floor space required. Full control for fourteen auxiliary feeders with metering and dummy buswork is assembled on one vertical panel only thirty inches wide. Similarly, the benchboard, which is designed to accommodate complete control for six generators and transformers with all their associated equipment and metering, occupies a floor space of only nine feet by four feet.

Other remote control features which may be mentioned in passing are such things as the closing of head gates and ventilating air louvres, the starting, stopping and operation of battery charging motor generator sets and the manual control of auxiliary transformer bank "on-load" tap changers.

Automatic Control

Under the heading of automatic control there is first, the operation of oil switches and disconnects by means of protective equipment and second, the maintaining of special services, such as air pressures, oil and water levels, voltages, temperature, sump drainage and so on.

(a) *Protective Service*

The development of relay protective schemes has advanced in recent years to a high pitch of perfection. The fundamental idea back of all relay protection is the isolation of the faulty section in the shortest possible space of time. This time element in the automatic opening of circuit breakers and field breakers plays a very important part in reducing hazards, in eliminating or tremendously diminishing the damage to equipment and in greatly assisting the continuity of service. In order to give an idea of the rapidity with which modern high speed protective relays and breakers operate the following illustration is of interest. Imagine a three-phase transmission line with the three conductors placed 20 feet apart, horizontally. If an aeroplane travelling at sixty miles an hour were to run into the line and cause a short circuit between the first wire and the second, the circuit breakers would have opened and disconnected the line before the machine could reach the third wire.

At Rapide Blanc, a wide variety of protective systems is employed, such as differential current relays for generators and transformers, unbalanced voltage relays for low voltage grounds, duplicate impedance or distance relays for short circuits or grounds on the transmission line and over current relays for auxiliary apparatus. Further security is obtained from systems known as standby or back-up protection. They form a second line of defence and they operate after a small interval of time, in the event of the failure of an oil circuit breaker or of the ordinary relays. Separate groups of impedance relays are provided in this

Fig. 3—Rapide Blanc Control Room showing Benchboard, illuminated Diagram and Protection Panels.

protection for every generator and transformer with their associated busses, and for short circuits or grounds on the transmission line.

An interesting automatic protective feature which is applied to all the main and feeder circuit breakers at Rapide Blanc is what is known as "trip-free" protection. This prevents the breaker being held in the closed position

Fig. 4—Auxiliary Panels in Control Room.
These Panels control the following Equipment (left to right):
1. Main lighting and automatic a.c.-d.c. transfer.
2. 48-volt battery and rectigon chargers.
3. 250-volt battery and two motor generator sets.
4. Auxiliary feeders and associated circuit breakers.
5. Main transformer temperature indication and auxiliary watthours.
6. Alarm lamps and waterlevel indicators.

when closed in on a faulty circuit. For example: Assume a transmission line feeder to be affected by lightning resulting in a voltage surge, followed by a flashover and power arc. The line breaker will immediately open and the operator will at once close it again hoping that the trouble is a transient one. If it is not, then the trip-free equipment will permit the breaker to open again at once and remain open, although the operator may continue for a time holding the control key to the "close" position.

While on the subject of automatic protective control, the 220,000-volt grounding switch should be mentioned. This somewhat unusual switch, which is, in reality, an air break disconnect, places a dead ground on each of two phases of the high voltage bus. It is made necessary by the fact that there are no high voltage oil circuit breakers at Rapide Blanc. In the event of line or transformer trouble, the ground switch immediately places a grounded short on the line, thus ensuring that the protective relays at the far end of the line will operate, even though the fault may be on the low voltage side of one of the transformer banks. The ground switch is motor operated and in common with the other motor operated disconnects requires only a starting impulse, the mechanism then going to full travel by virtue of lock-in relays and limit switches. In order to guard against accidental operation due to grounds occurring on the d.c. system, the control relays are so arranged that both positive and negative supplies are entirely disconnected when the motor is not actually in operation.

(b) Special Service

In the classification of what is called "special service," automatic control performs a great number of jobs, the majority of them more accurately and reliably than they could possibly be done by hand.

Most of this control apparatus is more or less standardized and well known, float switches and pressure switches operating a variety of air pumps, oil pumps and water pumps; but there are some features which, being a little out of the ordinary, will be considered briefly.

The sump, which is below the level of the tail race, is drained by two pumps, one of 20 h.p. and one of 75 h.p. A special float switch, which was designed and built by Shawinigan, controls both pumps and, in addition, provides on a dial an indication of sump level. Under normal conditions, only the small pump operates, starting and stopping about every twenty minutes, but should the small pump for some reason be unable to prevent the water rising, the large one will come into action for as long as may be necessary.

Since the supply of lubricating oil to the generators must on no account be interrupted, special pump control is provided. From two large tanks, situated high up, the oil flows by gravity to individual unit tanks kept full by float valves. From these unit tanks the oil is delivered to the machines, is re-collected, filtered and pumped up again into the large tanks. Two pumps are provided, one of which runs continuously, the surplus oil returning directly to the lubricating oil sump. Should the oil supply from this pump fail, the second pump will start as soon as the tank level drops to a predetermined point and it will continue running until switched off by the operator. This procedure occurs regardless of which of the two pumps may normally be running.

Illumination being very important, particularly in the control room, generator room and switch room, an automatic throw-over switch is provided which, in the event

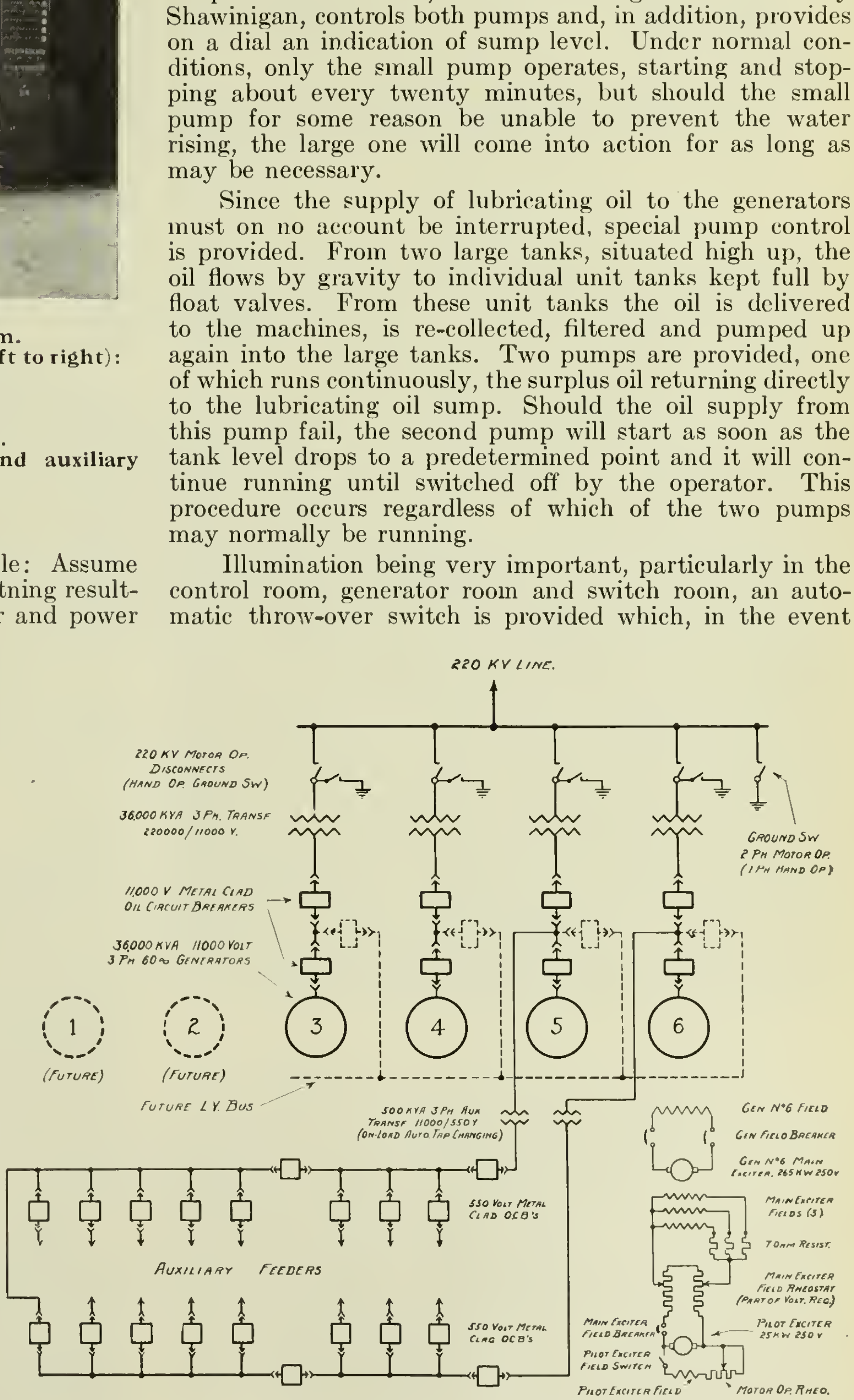

Fig. 5—Simplified Wiring Diagram.

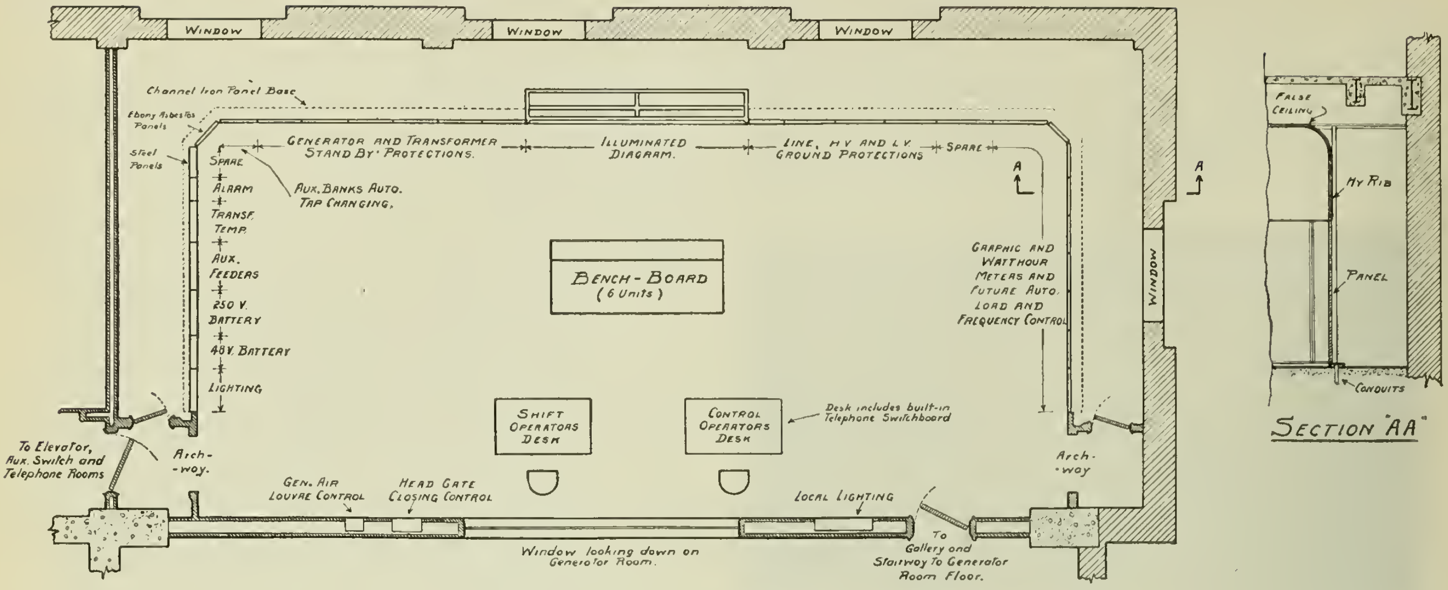

Fig. 6—Rapide Blanc Control Room—showing Panel and Control Layout.

of alternating current failure, transfers certain selected lamps throughout the power-house to the 250-volt battery, a mid tap from the battery taking care of the three wire lighting circuits. As soon as the supply is re-established, the lamps are returned to alternating current.

Automatic voltage regulation at Rapide Blanc is a little out of the ordinary and therefore interesting. The generator voltage regulators were manufactured by Brown Boveri in Switzerland and are of the high speed, heavy duty type, using oil pressure as an intermediate control. As far as the author knows, they are the only regulators of the kind in Canada. The regulating mechanism itself operates a rotary oil valve, which controls, by oil pressure, the position of two brushes which can move forward or backward around a fixed commutator. The bars of the commutator are connected to resistances in the output circuit of a pilot exciter and the brushes merely select the correct voltage for use on the field of the main exciter. In other words, it is really nothing more or less than an automatically operated potentiometer supplying d.c. to the field of the main exciter. Due to all the load being at a distance from the station, it is necessary to maintain constant voltage at the receiving point and this results in considerable variations in generator voltage as the load changes. To prevent this affecting the station auxiliaries, voltage control is provided in the form of on-load tap changers in the auxiliary transformer banks. These tap changers normally operate automatically but they can be worked by hand from the control room if desired.

Interlocks

An electrical interlock is merely an arrangement of wiring and auxiliary contacts whereby the operation of one piece of equipment is made dependent on the operation of another. Interlocks are exceedingly useful and are used in a great variety of ways. They guard against operating errors, prevent incorrect alarm indications and provide the correct sequence of operation in many types of automatic control. For instance, if an operator should attempt to open a transformer high voltage disconnect under load, without first opening the transformer oil circuit breaker, a very serious arc would be caused, probably developing into a cross short or ground. The disconnect is therefore interlocked electrically with the circuit breaker to prevent any possibility of this happening.

Alarm and Indication

In general, the work of an operator in a power-house consists of periods of uneventful routine with occasional hectic spells of activity when trouble occurs.

In order to lose as little time as possible in resuming service or eliminating danger to equipment, an alarm bell is essential. Several alarm bells, however, are a disadvantage. In the Rapide Blanc control room there is only one bell and it rings for every kind of serious trouble except two which are not urgent and are taken care of by a buzzer. Many troubles, such as overheated bearings, require some time to correct and meanwhile other difficulties may arise. Therefore an arrangement of relays is provided so that the bell may be stopped by momentarily pressing a button on the benchboard, after which it is immediately available again for any other trouble which may occur.

In a large plant, an immediate indication of the nature and location of the trouble is almost as important to the operator as the ringing of the bell itself.

Trouble indication at Rapide Blanc is carried out in two ways. What we may call mechanical troubles such as overheated transformers, overheated bearings, oil levels, water levels, oil pressures and so on, are shown by means of small red lamps and name-plates. There are sixty of these in the control room.

Electrical troubles are indicated by means of an illuminated station diagram on which the major circuits and equipment of the station are represented in lines and symbols of coloured light. Any alteration in the open or closed position of switches or disconnects and in the energized or de-energized condition of circuits or equipment is automatically represented by colour changes. In addition, any change resulting from the operation of the automatic protective relays will cause flickering of the section of the diagram affected and the symbol for the particular equipment or circuit which has failed will turn to a steady white.

The operators are thus advised instantly as to where the trouble is and to what extent it has affected the remainder of the station.

In concluding, one may see from the foregoing general outline that electrical control plays a vital part in the operation of a power-house and that correct design and application of control methods determine, to a considerable extent, the effectiveness of the station in supplying good power service.

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Transportation—The New Era

The changed conditions in the transportation industry have been the subject of recent addresses by a number of our public men, but there seems as yet to be little evidence that the serious nature of the problems that have arisen, and their vital effect upon the country's future, have been grasped by the general public. The man in the street does not yet realize that the railway problem, the development of highways and road transportation, the utilization of our waterways, and the establishment of airways, have such a bearing on the country's financial standing that a policy of drift in connection with them will have the gravest consequences.

Of these questions the railway problem is certainly the most pressing; its solution involves a study of all the other transportation agencies, with which the railways have to compete in their search for business. For this reason the timely information contained in a recent address by President Gaby, which we print elsewhere in this issue of The Journal, should be carefully studied. He very properly draws attention to the crushing burden of railway debt which weighs upon the Canadian people, and for which no political party seems able to provide any effective remedy. He points out that in the new era of land transportation, which has been brought about by the highway and the internal combustion engine, the railways, with their government controlled rates and strictly regulated methods of operation, are under a severe handicap in competing with the relatively unregulated busses and trucks operating on government built highways.

It is true that the railways have been criticized for not foreseeing and anticipating this competition. It is held that they should have forestalled the various private interests which have taken advantage of the new opportunities, and, assisted by the expenditure of public money on highways, and with the active support of the automotive industry, have covered the country with a network of bus and motor truck services. It must be remembered, however, that the railways, during this period of rapid change, have had to meet their own special troubles resulting from the depression, and that any expansion of their activities or change in their methods is subject to government approval. Any new developments in railway service are therefore liable to delay, so that private enterprise has, in many instances, been able to step in before the railway plans could be put into effect. In any case, the result has been that Canadian railways have not been able to do much in replacing unremunerative passenger trains by rail cars or their own motor busses, and, as regards freight, have seen a reduction in their revenue estimated at some thirteen million dollars per annum, due to the operation of privately owned motor trucks. The privately owned motor car has probably reduced the railways' passenger revenue by double that amount.

Dr. Gaby remarks, however, that the profitable operation of motor trucks is really limited to comparatively short hauls of small quantities of freight, and this is their natural field. Unregulated competition, or competition made possible owing to injudicious regulation, has nevertheless enabled trucks to take a considerable amount of the railways' long haul business, which, for runs of 500 miles, costs a railway less than one third of the real cost by motor truck.

Actually, our present composite transportation system, considered as a whole, is, like that in the United States, seriously inefficient and is not working to the best advantage of the country. Reduction in the volume of the railways' freight and passenger business has obviously increased its unit cost, in spite of the drastic economies which have been effected by the railway managements. Many of the main traffic routes, both road and rail, parallel each other, for they were laid out with a view of competition, not cooperation. Bus and truck operators often accept business at less than cost without due knowledge of all the factors entering into their financial operation. Nor is this kind of competition confined to the automotive field. As an example of the curious effect of governmental regulations and subsidies, it has actually been found worth while to transport loaded railway freight cars from New Orleans to New York in a specially constructed ocean-going steamer, instead of paying the regular freight rates for this service and permitting the cars to be hauled by locomotives over the railway tracks.

In aerial transport, the growth in Canada has been largely in districts, such as the northern mining areas, where other forms of transportation are as yet non-existent. In the United States, however, the air lines are in active competition with railways for long distance passenger traffic, and some progress has been made in coordinating their services with those of the railways.

"One of the lessons learned from the depression," said a recent speaker before the Franklin Institute in Philadelphia, "is that, throughout the world and on this continent particularly, we have gone ahead building up new forms of transportation and extending old forms without stopping to consider the relation which each must bear, one with another, or the relation of each to the whole economic structure. As a result, we have acquired an overhead of staggering dimensions. There may be some truth in the old saying that competition is the life of trade, but carried to extremes, competition, by placing too great burden on trade, may become its most deadly enemy."

What is the outlook for the future? Having regard to the new methods of transportation which have developed during the past twenty years, and which are undoubtedly here to stay, can the railways reasonably expect a growth of traffic from the sources still open to them which will enable them to meet their obligations out of their own revenue and not at the cost of the taxpayers? Even assuming that this growth will take place, there will still remain the waste due to the uncoordinated operation of our many transportation agencies. Dr. Gaby rightly observes that you cannot have duplication and multiplication of services in the same field and expect to have economy. Provision must be made for the reduction of unnecessary overhead, and the employment of each agency for the services which it is best fitted to perform. Only in this way can the efficiency of our transportation system as a whole be raised to the level which it should have if the Canadian public is to be properly served.

There is no prospect that this desirable result will be attained unless it is insistently demanded by well-informed public opinion. The supply of correct information on the various phases of transportation is peculiarly the province of the engineer, to whom the layman looks for a temperate presentation of the case, shorn of unnecessary technicalities and free from any political implications. Realizing this, the Council of The Institute is proposing to arrange, for the annual meeting of 1936, a symposium of papers on transportation subjects, designed to bring out, in as concise a form as possible, the basic facts and the relation of the various transportation systems to each other. This will enable members of The Institute to render a public service by first familiarizing themselves with the subject, and then using their influence to induce the laymen with whom they come in contact to take an active interest in the solution of its vital problems.

Report of Committee on Consolidation

No further meetings of the Committee on Consolidation have been held since the last report appearing in the June issue of The Journal, pending the receipt of replies to the Questionnaire at present before the Branches of The Institute and the Provincial Professional Associations.

The progress of the consideration of the questionnaire in the various provinces may be summarized briefly as follows:—

In Nova Scotia, the Association of Professional Engineers has been forwarded copies of the questionnaire for circulation to its membership and this matter will be discussed at a meeting of the Council at an early date. The Halifax Branch of The Institute has been forwarded copies of the questionnaire for study by their Executive, and a special committee on Consolidation is being appointed to co-operate with the central Committee. A Joint Committee of Eight for "Closer Union of the Association of Professional Engineers and The Engineering Institute of Canada in Nova Scotia" has made a report which has been approved by the Professional Association of Nova Scotia, the Halifax Branch and the Sydney Branch of the E.I.C.

In New Brunswick, the Moncton Branch is circulating the questionnaire to its membership for an expression of their individual opinion; also the Association of Professional Engineers of the Province of New Brunswick has requested copies of the questionnaire to circulate to its members. A meeting of the Council of this Association was held on June 21st, to consider Consolidation and to appoint members to act on a joint committee with the Saint John Branch and the Moncton Branch of the E.I.C. to discuss and report on the matter.

In the Province of Quebec, the Quebec Branch of the E.I.C. held a special meeting on June 17th, at which the questionnaire was considered and fully discussed and the engineers present unanimously approved affirmative answers to Questions No. 1, No. 3 and No. 5, also No. 2 with the qualification, "eventually." Question No. 4 was answered as "desirable" but an affirmative answer was considered to be dependent upon the uniformity of the benefits rendered by the National body to each member thereof. This report was accompanied by a memorandum by Mr. Hector Cimon, chairman of the Branch, dated January 25th, 1933, and submitted to the Annual Meeting of February, 1933. This most valuable recommendation should be made available to all members of the profession.

The Saguenay Branch of The Institute has appointed the following Committee to study the question of Consolidation and answer the questionnaire: H. R. Wake, A.M.E.I.C., J. Shanly, A.M.E.I.C., G. F. Layne, A.M.E.I.C., H. B. Pelletier, A.M.E.I.C.

At the request of the general membership of the Montreal Branch, a special meeting of the Branch was held on June 27th, to discuss the questionnaire and to take such action as may be considered to be in the best interest of the Branch and of the profession as a whole. The meeting resolved that the Questionnaire be sent to each member of the Branch to be returned on or before July 15th.

In Ontario, the Committee on Consolidation of the Niagara Peninsula Branch have returned the questionnaire with all questions answered unanimously in the affirmative. The Sault Ste. Marie Branch of The Institute is circulating the questionnaire to its members. The special committee of the Hamilton Branch of The Institute under the chairmanship of Mr. Hugh H. Lumsden, M.E.I.C., answered all questions in the affirmative. The questionnaire is being considered by a special committee on Consolidation of the Toronto Branch of The Institute. A special committee of the Professional Engineers of the Province of Ontario has been appointed to report on Consolidation and the questionnaire.

The special committee on Consolidation of the Province of Manitoba, under the chairmanship of Mr. A. J. Taunton, A.M.E.I.C., is issuing the questionnaire to all members of The Institute and the Professional Association of Manitoba.

In Saskatchewan, as previously reported, the special committee of The Institute and of the Professional Association, under the chairmanship of Mr. D. A. R. McCannel, M.E.I.C., have answered all questions in the affirmative.

In Alberta, the Edmonton Branch is circulating the questionnaire to its members.

In British Columbia, the Victoria Branch of The Institute is issuing the questionnaire to its membership. At an Executive meeting of the Vancouver Branch held on May 14th, a report on "The Engineering Profession in Canada and The Institute" prepared by Mr. P. H. Buchan, A.M.E.I.C., was accepted as being the expression of opinion of the Vancouver Branch on the Federation Problem, and forwarded to the Central Committee.

In order that the consideration of the question of Consolidation may progress uniformly across Canada, this Committee solicits the co-operation of all Branches, Special Committees and Associations, by their taking such action as will insure an early return on the "Questionnaire."

The Duggan Medal and Prize

The Council has great pleasure in announcing that through the generosity of Past-President G. H. Duggan, D.SC., LL.D., M.E.I.C., the series of prizes and medals of The Institute has been enlarged by the establishment of a fund, from the proceeds of which a gold medal and prize of a total value of approximately One Hundred Dollars will be offered annually for competition.

The founder's purpose is to encourage the development of the branches of engineering with which his name is associated, and accordingly the medal and prize will be awarded for the best paper submitted during The Institute prize year and dealing with some phase of constructional engineering in which metals are employed in moulded or fabricated shape for structural or mechanical purposes.

The competition will be open only to members of The Engineering Institute of Canada, and to be eligible, papers must not have been published elsewhere or have been presented before any other body.

Fuller details of the conditions attaching to this valuable donation are being worked out and will be published in an early issue of The Journal.

Field Marshal Julian Hedworth Byng, First Viscount Byng of Vimy, G.C.B., G.C.M.G., M.V.O., Hon. M.E.I.C.

It is with deep regret that it is necessary to record the death at Thorpe-le-Soken, England, on June 6th, 1935, of Field Marshal Julian Hedworth Byng, first Viscount Byng of Vimy, G.C.B., G.C.M.G., M.V.O., Hon.M.E.I.C.

The seventh son of the second Earl of Strafford, Lord Byng was born on September 11th, 1862, and like so many younger sons of the British aristocracy, he chose the army as his career. In 1883, following a short period in the militia, he joined the regular forces, and at the age of twenty-one was posted as a subaltern officer to the 10th Royal Hussars. Proceeding to Egypt within a few months from his joining the Hussars, he found himself in February, 1884, operating with a squadron of his regiment which was attached to the punitive force of General Graham against the notorious Osman Digna, and he was in action for the first time at El Teb on February 28th. He was adjutant of the Hussars for four years, and in 1890 was promoted captain. Another eight years elapsed before he attained field rank, but from then on the rapidity of the changes when developed in the army amply compensated Lord Byng for his lengthy period of probation. At the outbreak of the Boer War he went to South Africa with his regiment and was soon appointed to command the South African Light Horse as brevet Lieutenant-colonel. This regiment operated in Lord Dundonald's 2nd Mounted Brigade and Lord Byng was in action at Colenso and Standerton.

Returning to England in 1902 he was appointed to command his old regiment, the 10th Royal Hussars, and from that time until the opening of the Great War his military career followed a well-ordered course. Successively commandant of the Cavalry School at Netheravon and commander of the 2nd Cavalry Brigade, he was promoted major-general in 1909, and for two years commanded the East Anglian (Territorial) Division. In 1912 he proceeded to Egypt.

Field Marshal Julian Hedworth Byng, First Viscount Byng of Vimy.

The outbreak of the War found Lord Byng in Egypt, where after two years as General Officer Commanding the Army, he received the order, late in September, 1914, to report for service in France. Between October 6th and 8th, the 3rd Cavalry Division, commanded by Byng, and the 7th Division, landed at Ostend and Zeebrugge. Included in the former formation was Byng's own regiment, the 10th Royal Hussars, who had recently arrived from Potchefstroom, South Africa.

Lord Byng's force hastened to Bruges where, on October 9th, he learned that Antwerp had fallen that day. Falling back from Thourout to Roulers, Byng's division entered Ypres on October 13th, the first British soldiers to enter that town. On October 20th began the first battle of Ypres. Later on Lord Byng reported to duty in Gallipoli and was assigned to the command of the IX Corps. He remained in the Dardanelles until the evacuation and returned to France in February, 1916, to take command of the XVII Corps. His association with that force was brief, for within four months his transfer to the command of the Canadian Corps took place, and on May 28th, 1916, began a connection between Byng and the Canadian Corps which lasted for over a year and added to the renown of both. Subsequently Lord Byng was promoted to command the Third Army and later on became a full general.

During his command of the Canadian Corps, Byng won the affection and respect of all ranks, and nothing could have been more popular than his appointment in 1919 to be Governor General of Canada in succession to the Duke of Devonshire.

He came to Canada in 1921 and during his term as Governor General not only deepened the affectionate regard in which he was held by the Canadians who served under him in France, but also became one of the most popular representatives of the Crown in the history of the Dominion.

Following his return to England in 1926 Lord Byng retired to his estate at Thorpe-le-Soken in Essex, and for a time was out of the public eye, until in 1928 he was offered and accepted the post of Chief Commissioner of the Metropolitan Police Force of London. He retired from that office in 1931 after reorganizing the Force and restoring it to a position commanding public confidence.

In 1932 Lord Byng was elevated to the rank of Field Marshal. He was the recipient of many honours from foreign governments, being Grand Officer of the Legion of Honour, with the Croix de Guerre of France, the Grand Cross of the Order of the Crown of Belgium, and the Belgian Croix de Guerre, the Grand Cross of St. Vladimir of Russia (with swords), the American Distinguished Service Medal and the Order of the White Eagle of Serbia (with swords).

On his appointment as Governor General, Lord Byng graciously consented to become an Honorary Member of The Engineering Institute of Canada, and was duly elected on January 10th, 1922.

OBITUARY

George Henry Richardson, A.M.E.I.C.

It is with regret that we place on record the death at Kelowna, B.C., on June 10th, 1935, of George Henry Richardson, A.M.E.I.C., a member of many years standing.

Born at Toronto, Ont., on May 26th, 1868, Mr. Richardson graduated from the School of Practical Science, University of Toronto, in May 1888, and subsequently joined the staff of the Canadian Pacific Railway Company. From March to August 1889 Mr. Richardson was assistant engineer on construction of the railway between London and Windsor, and in April 1890 he was transferred to Toronto as assistant on the Don branch and Esplanade work. In 1891 he became assistant engineer on the Niagara Falls Park and River Railway, and in 1893 went west as transitman on surveys and location for the Crow's Nest Pass railway; later on he was assistant engineer on the Revelstoke and Arrow Lake branch of the Canadian Pacific Railway. In 1903-1903 Mr. Richardson was assistant engineer for the city of Ottawa. He went to Vancouver Island during the latter part of the Great War, and was engaged as location engineer on the railway extension from Alberni to Central Lake. After completing that work he retired and made his home in Victoria, but in 1923 was appointed municipal engineer of Oak Bay, B.C., which office he held until the time of his death.

Mr. Richardson joined The Institute (then the Canadian Society of Civil Engineers) as a Student on February 24th, 1887, and on May 23rd, 1895, became an Associate Member.

PERSONALS

Engineer Commander Angus D. M. Curry, M.E.I.C., has been appointed Director of Naval Engineering, Naval Service, Department of National Defence, Ottawa, Ont.

B. Russell, M.E.I.C., of Vancouver, B.C., has been appointed as senior engineer in charge of water supply investigations in the Prairie Provinces, and will make his headquarters at Medicine Hat, Alta.

A. N. Budden, A.M.E.I.C., of the Dominion Engineering Company Limited, has been transferred to the company's Toronto office. Mr. Budden was formerly located at Montreal.

K. M. Winslow, A.M.E.I.C., formerly with the Dominion Engineering Company Ltd., at Toronto, has been transferred to Montreal.

R. M. Smith, A.M.E.I.C., Deputy Minister, Department of Public Highways of Ontario, has been appointed by the Ontario government to assist the Grand River Conservation Commission in further projecting its conservation programme.

Horace L. Seymour, M.E.I.C., town planning consultant of Ottawa, has been retained by the Saint John, N.B., Town Planning Commission to advise them in the preparation of a new Town Planning Act for New Brunswick and to consult with them on specific problems of town planning and housing in Saint John and district.

John N. Flood, Jr., A.M.E.I.C., is chairman, and A. R. Crookshank, M.E.I.C., is secretary of the Saint John Town Planning Commission. Under the proposed act the scope of the Commission will be widened and the co-operation of local technical organizations is being sought. The local Branch of The Institute has shown great interest in the movement.

Major E. L. M. Burns, O.B.E., M.C., A.M.E.I.C., General Staff Officer Surveys, Geographical Section, Department of National Defence, Ottawa, was made an Officer of the Order of the British Empire (Military Division) in the King's Birthday Honours List for 1935. Major Burns who is a graduate of the Royal Military College, Kingston, of the year 1915, spent three years on active service during the late war. During the years 1928-1930 Major Burns was stationed at Quetta, India, where he attended the Staff College, and prior to his present appointment, he was district engineer officer for Military District No. 5, Quebec, Que.

Raymond A. Yapp, A.M.EI.C.

Raymond A. Yapp, A.M.E.I.C., has been appointed sales manager of Bepco Canada Limited, of Montreal and Toronto, which is an amalgamation, in Canada, of Bruce Peebles (Canada) Ltd., Harland Engineering Company of Canada Limited, Crompton Parkinson Canada Limited and the Lancashire Dynamo and Crypto Company of Canada Limited. Mr. Yapp graduated from the University of London in 1921 with the degree of B.Sc., and following graduation joined the firm of Lancashire Dynamo and Crypto Company Limited. About eleven years ago he came to Canada and joined the Toronto office of the company, and later was transferred to Montreal where he is now located.

Dr. Charles Camsell, C.M.G., LL.D., F.R.S.C., F.G.S.A., M.E.I.C., Deputy Minister of Mines, Ottawa, and a Past-President of The Institute was made a Companion of the Order of St. Michael and St. George in the King's Birthday list of Honours recently published. Dr. Camsell, who has explored all northern Canada, joined the Canadian Geological Service in 1904 and much of the mapping of the north was due to his exploration. Dr. Camsell was vice-president of the Canadian Institute of Mining and Metallurgy in 1921-1922, vice-president of the Royal Society of Canada in 1930, becoming its President in 1931, was President and one of the founders of the Canadian Geographical Society. Dr. Camsell was President of The Engineering Institute in 1932. Among his academic honours may be noted the degrees of LL.D. which he received from Queen's University in 1922 and from the University of Alberta in 1929. His achievements as an explorer were recognized in 1922 by the award to him of the Murchison Grant by the Royal Geographical Society as an appreciation of his services in exploring northern Canada; his long connection with the mining industry was fittingly acknowledged in 1931 when the Institution of Mining and Metallurgy, London, presented him with its gold medal for his work in promoting the development of the natural resources of the Dominion and furthering the general interests of the mineral industry.

Major-General A. G. L. McNaughton, C.M.G., D.S.O., LL.D., M.E.I.C., has been appointed chairman of the National Research Council, Ottawa, in succession to Dr. H. M. Tory. Major-General McNaughton has been for the past six years chief of the General Staff in the Department of National Defence. He graduated from McGill University in 1910 with the degree of B.Sc., and in 1912 with the degree of M.Sc., and during the years 1910 to 1914 was attached to the department of electrical engineering at the same university. In 1914 Major-General McNaughton was engaged in engineering practice in Montreal, carrying out numerous investigations for the late Dr. L. A. Herdt, M.E.I.C., on subjects connected with electrical engineering. He then served overseas with very high distinction, and, upon his return to Canada, joined the permanent force and was appointed to the command of military district No. 11, at Victoria, B.C. In 1929 he was transferred to Ottawa as Chief of the General Staff and member of the Defence Council. He has been largely responsible for the organization and administration of the relief camps and projects throughout the country, which were established in 1932 and have assisted many thousands of single unemployed homeless Canadians.

J. Clark Keith, A.M.E.I.C., chief engineer of the Essex Border Utilities Commission, has been appointed finance comptroller of the new City of Windsor, which includes Windsor, Walkerville, Sandwich and East Windsor. As comptroller he will be the chief executive officer of the new city in charge of all departments, and responsible to a newly-appointed three-man finance commission, which has general supervision over all financial affairs of the new city. Mr. Keith graduated from the University of Toronto in 1911 with the degree of B.A.Sc., and in 1912-1920 was municipal engineer of the city of Moose Jaw. In 1920 he was appointed deputy chief engineer of the Essex Border Utilities Commission and the following year was appointed chief engineer of the Commission. In 1932 Mr. Keith became business administrator of the Metropolitan General Hospital in addition to his other duties, and in 1934 he was made chief executive officer of the Commission. With the merging of the four municipalities, the functions of the Essex Border Utilities Commission will be assumed by the Windsor Utilities Commission with which Mr. Keith will probably still be identified.

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Tuesday, June 18th, 1935, at eight o'clock p.m., with President F. A. Gaby, M.E.I.C., in the chair, and ten other members of Council present.

A report was received from the special committee appointed by Council, under the chairmanship of Mr. C. M. Pitts, A.M.E.I.C., to consider any action which it might be possible for Council to take in connection with the housing problem. Letters of comment from a number of councillors were also considered, and discussion took place, after which the report was approved and the Secretary was directed to draw the attention of the National Construction Council to the desirability of giving further consideration to the possibility of providing low cost houses, with an offer of Council's assistance should an investigation along these lines be thought desirable.

Prolonged consideration was given to a charge of unprofessional conduct and the representations of one of The Institute branches regarding it, after which it was resolved that in this case sufficient grounds had not been disclosed to institute a formal investigation.

A report was presented from a committee appointed by Council, under the chairmanship of Mr. J. A. Vance, A.M.E.I.C., to study the conditions of employment of engineers under the Highway Improvement Act of Ontario. After considerable discussion the report was approved, and the committee was authorized to make representations to the officers of the Provincial Government in accordance with the recommendations contained in the report.

The Secretary reported receipt of the securities donated to The Institute by Past-President Duggan and constituting the fund for the prize which he is establishing, and stated that in accordance with Council's directions he had written to Mr. Duggan expressing Council's gratitude for this generous gift.

It was noted with appreciation that Mr. E. P. Muntz, M.E.I.C., had consented to act as The Institute's representative on the National Construction Council of Canada, and that Mr. A. H. Harkness, M.E.I.C., would continue to act as alternate representative.

A progress report was presented from Colonel C. S. L. Hertzberg, M.E.I.C., chairman of the Papers Committee of The Institute, drawing attention to the service which could be rendered to The Institute by prominent members who have occasion to travel if they would take the opportunity of stopping off and addressing outlying branches.

Two resignations were accepted, three reinstatements were effected, one member was replaced on the active list, and a number of special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

Elections		*Transfers*	
Assoc. Members	5	Assoc. Member to Member	2
Juniors	2	Junior to Assoc. Member	1
Affiliate	1	Student to Junior	3
Students admitted	7		

The Council rose at twelve o'clock midnight.

The Past-Presidents Prize 1935-36

The Council has selected as the subject of the essays to be submitted for the competition for the prize year July 1st, 1935 to June 30th, 1936:—

The Engineer's Contribution to Transportation

The rules governing the award of this prize are as follows:—

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved as the case may be.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July 1st to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received during the prize year by the General Secretary of The Institute, either direct from the author or through a local branch.

THE ENGINEERING INSTITUTE OF CANADA

RECORD OF MEMBERS WHO SERVED OVERSEAS

1914-1918

Council has given instructions that the permanent bronze tablet giving a list of those members of The Institute who served overseas is to be proceeded with. This will complete The Institute's War Memorial and the following list of names will be placed on record. Corrections can be made if received not later than August 1st, 1935.

This list has been made up in accordance with the instructions of Council to include the names of all those who belonged to The Institute in any class of membership and during that membership served with the allied land, air or naval forces outside of Canada and the United States between August 1914 and November 1918.

C. A. Ablett, O.B.E.
J. Adam
W. A. Adam, M.C.
F. P. Adams
W. D. Adams, M.C.
E. K. Adamson
L. S. Adlard
A. W. Agnew
A. B. Aitken, M.C.
A. M. Alberga
G. F. Alberga
F. G. Aldous
K. Alexander, O.B.E.
E. B. Allan, M.C.
H. D. Allan
L. E. Allen
F. Alport, M.C.
F. X. Amoss, M.C.
A. A. Anderson, D.S.O.
A. C. Anderson
A. G. Anderson, M.M.
G. F. Anderson, M.C.
T. V. Anderson, D.S.O., (F)
D. G. Anglin
L. Annereau
C. J. Armstrong, C.B., C.M.G., (F)
J. D. Armstrong
R. F. Armstrong, M.C.
W. Armstrong
A. P. Augustine
F. D. Austin
C. R. Avery

T. H. Bacon
H. C. Baker, Jr., M.C.
J. C. Ball, D.S.O., O.B.E., (F)
S. Ball
T. B. Ballantyne
R. G. Bangs
N. M. Barclay, M.C.
H. F. Barnes
L. F. Barnes
W. C. Bate, M.C. & Bar
H. E. Bates
C. Batho
M. E. Bauset
C. M. Bayne
F. K. Beach
H. P. Beaudoin
J. M. Begg
G. E. Bell
D. P. Bell-Irving
G. A. Bennet
C. S. Bennett
H. F. Bennett
B. C. Berry
M. C. J. Beullac
D. W. Bews
R. Bickerdike, Jr., D.S.O. & Bar
L. M. Bidwell
J. R. Biggs
P. V. Binns, M.C.
E. R. Birchard
J. M. Bishop
T. A. G. Bishop
A. P. Black
J. W. B. Blackman
W. E. Blue, D.S.O.
H. L. Bodwell, C.M.G., D.S.O., (F)
J. L. H. Bogart, D.S.O.
E. J. Bolger
F. L. C. Bond, D.S.O.
C. D. G. Booth
P. D. Booth, D.S.O., M.C.
M. L. Boswell
W. Bowden
E. P. Bowman
F. Bowman
J. H. Brace
J. H. Bradley
W. Brass
J. F. Brett
F. E. A. Bremner
F. M. Brickenden
E. D. G. Brouse
C. K. Brown, M.C.
C. W. Brown, M.C.
D. M. Brown
J. C. Brown, O.B.E.
L. B. Brown
W. G. Brown
E. F. Browne
G. A. Browne
G. H. Brunner
W. F. M. Bryce
C. A. Buck
R. S. Buck, D.S.O.
S. W. Bulman

(F) Foreign Orders.

H. L. Bunting, M.C.
F. R. Burfield
G. K. Burnett
B. H. A. Burrows
G. A. Butler
T. H. Byrne

W. P. Caddell
J. F. F. Cahan
R. M. Calvin
C. S. Cameron
J. A. Cameron
O. L. Cameron
A. Campbell
J. J. Campbell, M.C.
T. C. Campbell
W. I. H. Campbell
F. L. Cann
C. M. Canniff
C. L. Cantley
E. G. M. Cape, D.S.O.
C. N. T. Carnsew, M.C.
J. Carroll
H. R. Carscallen, M.C.
C. L. Cate
J. E. Caughey
A. L. Cavanagh, M.C.
F. G. Chadwick, M.C.
H. D. Chambers
F. Chappell
H. H. Charles
P. Charton, (F)
M. P. Chevalier
C. G. Childe
K. G. Chisholm
C. W. U. Chivers, D.S.O., M.C.
H. R. M. Christie
A. W. G. Clark
F. Clarke
F. F. Clarke, D.S.O. & Bar
T. W. Clarke, M.B.E.
J. Clendinning
H. G. Cochrane
J. R. Cockburn, M.C.
R. N. Coke
G. E. Cole
E. V. Collier, D.S.O.
C. Collingwood, M.M.
W. S. Collins, M.C.
H. S. Cooper
J. H. Cornish
J. R. Cosgrove, D.S.O., M.C.
G. W. Coward
R. P. Cowen
A. T. N. Cowley
F. P. V. Cowley
F. A. Creighton, (F)
H. C. Craig
J. C. Craig, D.S.O.
E. A. Crawley
J. A. Creasor, M.C.
H. T. Crosbie
F. G. Cross
W. B. Crossing
H. Crutchfield
C. R. Crysdale, M.C.
J. G. Culshaw
A. L. Cumming
A. I. Cunningham
J. H. Curzon

C. A. d'Arrast D'Abbadie
W. R. C. DaCosta
F. A. Dallyn
G. F. Dalton, M.C.
W. T. Daniel
E. F. M. Dann
G. H. Davis
W. E. Davis, D.S.O.
W. M. Davis
H. Daw
A. S. Dawes, M.C.
F. J. Dawson
I. H. Dawson, M.C.
J. K. Dawson
G. deCardaillac, (F)
C. S. deGruchy, M.C.
C. T. deKam
J. A. DeLancey, M.C.
F. J. Delaute, O.B.E.
H. G. S. Delepine
A. C. J. de Lotbiniere, C.B., (F)
S. N. deQuetteville
L. H. Derrer
R. A. deValter
E. V. Deverall, M.C. & Bar

W. J. Dickson, M.M.
W. N. Dietrich
J. V. Dillabough
H. G. Dimsdale, M.C.
W. W. Dines
G. B. Dixon
F. W. W. Doane
W. L. Dobbin
G. J. Dodd
C. A. Doherty
J. M. Donaldson
P. E. Doncaster
C. B. C. Donnelly, (F)
C. O. Donnelly
H. H. Donnelly
J. W. Dorsey
F. W. Douglas
E. E. Down
R. W. Downie
W. H. Draper
F. S. Drummond
L. Drummond
A. E. Dubuc, D.S.O. & Bar, (F)
C. G. DuCane, O.B.E.
P. B. Duff
J. C. Dufresne
H. S. Duggan
K. L. Duggan
A. F. Duguid, D.S.O.
P. E. Dulieux
E. Duncan
W. E. P. Duncan
H. J. Dunlap, M.C.
G. Dupont
H. A. Dupre, M.C.
F. S. Dyke

R. S. Eadie
E. A. Earl
F. G. Earle
H. Earle
L. I. Easton, M.C.
H. T. Eaton
A. C. Eddy
J. H. Edgar
C. W. Edmonds
A. J. Edward
H. A. Elgee
G. R. Elliott
D. S. Ellis, D.S.O.
J. Ellis
J. G. St.J. Ellis
S. C. Ells
F. E. Emery
F. H. Emra, O.B.E.
D. J. Emrey, M.C., M.M.
A. E. Evans
G. W. F. R. Evans, M.C.
W. M. Everall
C. Ewart, D.S.O.
D. M. Ewart, M.C.
W. A. Ewing, M.M.

R. M. Fair
J. Farrow
A. W. Ferguson
G. H. Ferguson
G. H. Ferguson, M.C.
J. Ferguson
L. L. Ferguson
T. Ferrier
C. B. Ferris, D.C.M., (F)
C. V. Fessenden
E. P. Fetherstonhaugh, M.C.
W. S. Fetherstonhaugh, C.B.E.
P. A. Fetterly
E. G. Fiegehen
W. M. Fife
A. D. Fisken, M.C.
G. O. Fleming
F. P. Flett
C. Flint, D.S.O., (F)
W. J. Forbes-Mitchell, D.S.O.
W. S. Ford
J. L. Foreman
E. S. Fowlds
F. S. Fowler, M.C.
C. J. Fox, M.C.
W. L. Frame
E. W. Francis
C. E. Fraser
J. A. Fraser
W. G. French, M.M.
C. H. R. Fuller
F. Fyshe

C. E. Gage
O. J. Gagnier
J. S. Galbraith, M.C.
R. D. Galbraith, M.C.
O. G. Gallaher
A. Galloway
J. C. Galway
C. W. Gamble
W. M. Gardner
A. C. Garner, D.S.O.
A. B. Garrow
F. M. Gaudet, C.M.G., (F)
A. J. Gayfer
G. Gear
C. N. Geale
C. F. Gervan
H. M. Gibb
J. M. Gibson, D.S.O.
J. M. Gilchrist
L. W. Gill
J. R. Gilley
A. Gillies
W. C. Gillis
E. P. Girdwood
R. deB. Girouard
J. C. Glanville
F. W. Glover
T. S. Glover, M.C.
F. T. Gnaedinger, M.M.
B. Godwin
E. C. Goldie, D.S.O.
G. A. Gooderham
M. L. Gordon
D. F. Gorrie
D. A. Graham
D. S. Graham
E. R. Grange, D.S.C., (F)
J. R. Grant, M.C.
LeR. F. Grant
R. P. Graves
A. W. Gray
L. K. Greene
P. W. Greene
E. O. Greening
A. H. Greenlees
H. S. Greenwood
A. W. Gregory, M.C.
W. A. E. Grim
E. Grummitt
R. W. Guy, M.M.
H. N. Gzowski

H. Hadley
H. J. A. Haffner
J. S. Hall
N. M. Hall, O.B.E.
T. E. A. Hall
G. M. Hamilton, M.C.
H. E. R. Hamilton
J. Hammersley-Heenan
H. S. Hancock, Jr.
J. Handley
C. F. Hanington
J. J. Hanna
J. T. Hanning
R. H. Harcourt
W. G. Hardy
R. B. Harkness, D.S.O., (F)
J. F. Harkom, M.C.
J. W. Harkom
A. D. Harris
R. W. Harris
E. H. Harrison, M.C.
J. P. Harvey, M.C.
F. G. Haven
E. E. Hawkins
S. H. Hawkins, M.C.
A. K. Hay
N. K. Hay, (F)
W. W. Hay
L. T. Hayman
J. G. Hayward
T. J. C. Heeney
J. G. Helliwell
R. A. Henderson
T. D. Henderson
C. S. L. Hertzberg, M.C., (F)
H. F. H. Hertzberg, C.M.G., D.S.O., M.C.
C. L. Hervey, D.S.O.
J. A. Hesketh, C.M.G., D.S.O.
E. P. Heywood
H. P. Heywood
J. H. Hewson
H. C. Hick
E. M. M. Hill
D. Hillman, D.S.O.
W. E. Hobbs

H. W. Hodge
A. E. Hodgins
F. O. Hodgins, D.S.O.
H. M. T. Hodgson
B. B. Hogarth
C. E. Hogarth
A. Holland
G. C. Hoshal
J. W. Houghton
J. Houliston, D.S.O.
J. A. Houston
B. H. Hughes
C. A. Hughes, M.M.
G. B. Hughes, C.B., C.M.G., D.S.O.
H. T. Hughes, C.M.G., D.S.O.
E. E. H. Hugli
G. B. Hull
A. E. Humphrey, D.S.O.
W. H. Hunt, M.C.
W. H. Hunter
W. B. Hutcheson

C. J. Ingles, D.S.O.
C. W. Innes
J. H. Irvine
J. C. Irving
T. C. Irving, D.S.O.

A. M. Jackson
R. Jacquemart
J. H. E. Jaffary
E. A. Jamieson
G. A. F. R. Janin
P. J. Jennings, O.B.E.
T. Jepson
E. N. Johnson
G. A. Johnson, M.C.
B. A. Johnston
G. W. F. Johnston
H. W. Johnston
J. H. Jones
W. G. Jones
W. H. Jones
R. L. Junkin, M.C.

J. A. Keefer, M.C.
A. J. Kelly, M.C. & Bar
J. C. Kemp, D.S.O., M.C.
H. C. Kennedy
H. E. M. Kensit
E. S. Kent
V. J. Kent
A. R. Ketterson, D.S.O.
W. W. King
L. B. Kingston, M.C.
L. W. Klingner, M.C.
F. W. Knewstubb
A. G. Knight, D.S.O., M.C.
F. C. Knight
J. A. Knight, M.C.
G. H. Kohl
F. H. Kortright

L. H. Laffoley
P. A. Laing, M.C.
H. J. Lamb, D.S.O.
S. R. Lamb
Y. Lamontagne
G. E. LaMothe, M.C.
C. S. Landon
P. A. Landry, O.B.E.
A. J. Latornell
F. M. Lawledge
A. J. Lawrence
W. S. Lawrence
G. F. Layne, M.C.
S. T. Layton, M.C.
F. E. Leach
R. G. E. Leckie, C.M.G.
W. J. LeClair
P. L. P. LeCointe, (F)
H. Lefebvre, M.C.
A. G. T. LeFevre, D.S.O., (F)
A. Leger
A. H. Legge
V. J. Lennox
I. Leonard, D.S.O.
C. C. Lindsay, M.C., (F)
G. A. Lindsay
R. E. Lindsay
A. P. Linton, O.B.E.
E. C. Little, (F)
D. A. Livingston
F. F. Longley, C.B.E., (F)
W. E. Longworthy, M.C.
H. R. Lordly
H. C. Lott, M.C.
T. R. Loudon
W. E. Lovell
N. Lowden, M.C.
E. J. Lowe
F. T. Lucas
H. A. Lumsden
R. G. Lye
D. Lyell, C.M.G., C.B.E., D.S.O., (F)
C. D. Lyon, M.C.
E. N. Lyon
E. L. Lyons

C. A. Macaulay
F. Macarthur
A. C. MacDonald, D.S.O., (F)
A. T. Macdonald
C. A. Macdonald
C. B. R. Macdonald
J. C. MacDonald, M.C.
L. S. MacDonald
W. M. B. Macdonald

(F) Foreign Orders.

A. E. MacGregor
J. G. MacGregor, M.S.M.
B. H. T. Mackenzie
C. J. Mackenzie, M.C.
H. J. MacKenzie, M.C.
J. A. MacKenzie, D.S.O.
J. F. MacKenzie
W. L. Mackenzie
K. R. MacKinnon, M.C. & Bar
M. A. MacKinnon
O. T. Macklem
J. B. MacLachlan, M.C.
R. C. MacLachlan
G. P. MacLaren
D. G. MacLean
N. J. Maclean
T. A. MacLean
A. L. MacLennan
G. G. MacLennan, (F)
G. MacLeod
G. W. MacLeod, D.S.O. & Bar
A. Macphail, C.M.G., D.S.O., (F)
D. MacPherson
O. C. Macpherson, O.B.E.
J. P. Macheras
C. M. Macreath
C. B. Magrath
W. H. Magwood
H. L. Mahaffy
H. W. Mahon
T. C. Main, (F)
W. L. Malcolm
C. S. Manchester
H. S. Manisty, M.C.
A. B. Manson
O. J. Marchbank
J. Marshall
J. A. P. Marshall
B. E. Martin
J. Mason, D.S.O., M.C.
W. Matheson
J. E. Mathews, M.C. & Bar
C. H. Mathewson, M.C.
D. M. Mathieson, M.C.
G. S. Maunsell
W. G. Mawhinney
J. D. McBeath
W. R. McCaffrey
N. F. McCaghey, D.S.O., M.C.
J. W. McCammon
G. A. McClintock
S. E. McColl
T. C. McConkey
H. E. McCrudden
G. E. McCuaig, C.M.G., D.S.O. & Bar
M. W. McCutcheon
S. S. McDiarmid
H. F. McDonald, C.M.G., D.S.O., (F)
J. N. McDonald
A. McDougall, C.B., (F)
A. L. McDougall
A. B. McEwen, D.S.O.
M. L. D. McFarlane
W. T. McFarlane
F. A. McGiverin, M.C.
J. McGregor, D.S.O.
W. A. McInnes
E. D. McIntosh
W. L. McIntosh
J. K. McKay
R. McKillop
A. W. McKnight
R. C. McKnight
D. B. McLay
E. B. McLean
J. Reg. McLean
J. Rose McLean
N. B. McLean
R. A. McLellan
A. G. McLerie
W. S. McMaster
H. C. McMordie, M.C.
A. G. L. McNaughton, C.M.G., D.S.O.
J. A. McNicol
J. McNiven
D. S. McPhail
M. N. McPhee, M.C.
A. J. McPherson
H. R. McQueen
J. P. McRae
H. G. McVean
A. de C. Meade, M.C.
J. C. Meade
F. C. Mechin
V. M. Meek
A. U. Meikle, M.C.
J. M. Menzies
L. F. Merrylees
W. C. Merston, M.C. & Bar, D.C.M.
H. F. V. Meurling, D.S.O., M.C., (F)
V. Michie
J. R. Middleton
A. L. Miéville, D.S.O., M.C.
L. Mignault
A. P. Miller, D.S.O., M.C. & Bar
A. S. Miller
H. B. Miller, M.C.
W. C. Miller
W. M. Miller, M.C.
C. A. Millican
F. S. Milligan, M.C.
F. O. Mills
L. G. Mills
A. H. Milne
J. E. Milne
J. A. Milot
C. H. Mitchell, C.B., C.M.G., D.S.O., (F)
C. N. Mitchell, V.C., M.C.
G. Mitchell, M.C.
J. C. Mitchell

R. W. Mitchell, M.C.
J. Monckton-Case
W. Monds
G. H. N. Monkman
T. M. Montague, (F)
S. C. Montgomery, M.C.
G. C. P. Montizambert
H. St.J. Montizambert
W. H. Moodie, D.S.O.
F. H. Moody
F. M. Mooney
W. N. Moorhouse, D.S.O., (F)
P. J. Moran
B. M. Morris
H. I. Morris
H. F. Morrisey
T. S. Morrisey, D.S.O., (F)
H. K. Morrison
J. H. T. Morrison
J. R. Morrison
T. E. Morrison
H. M. Morrow, M.C.
G. P. Morse
F. R. Mortimer
H. A. Morton
K. W. Morton
G. B. Moxon
H. B. Muckleston
R. Mudge
T. Muirhead
J. M. L. G. Mullon
R. H. Mulock, C.B.E., D.S.O. & Bar
A. H. Munro
J. H. Munro
W. H. Munro
E. P. Muntz
P. F. Murphy
H. A. Murray
J. Murray, M.M.
N. Murray
R. H. Murray
V. F. Murray
W. P. Murray, M.C.
J. C. Murton

T. E. Naish
C. R. Needs
S. A. Neilson
D. H. Nelles
A. Nowlan

S. M. Oborn
A. A. Oldfield
F. J. O'Leary, D.S.O., M.C. & 2 Bars
H. G. O'Leary
J. E. Openshaw
R. H. O'Reilly
C. D. Otty
G. N. D. Otty
R. B. Owens, D.S.O.
A. C. Oxley, M.C., D.C.M.
J. M. Oxley

J. A. Page
H. M. Pardee
J. Paris
C. S. Parke
S. D. Parker
J. H. Parks, D.S.O., O.B.E., (F)
C. B. Parr
C. St.C. Parsons
R. H. Parsons
P. deL. D. Passy
A. L. Patterson
R. G. Patterson, M.M.
L. F. Pearce, D.S.O., M.C.
W. G. Pearse
H. M. Peck
E. Peden
H. B. Pelletier
E. H. Pense
H. W. Perkins
G. W. H. Perley
B. R. Perry
C. V. Perry, M.C.
K. M. Perry, D.S.O. & Bar
S. M. Peterkin
H. Peters
F. A. Pickering
E. R. B. Pike
H. H. Pinch
R. C. L. Pinget, (F)
W. A. Plant, M.M.
A. S. Poe
R. A. Pook
W. B. Porte
A. T. Powell, D.S.O.
R. W. Powell, M.C. & Bar
T. E. Powers, D.S.O.
A. L. Powter
T. E. Price
J. E. Pringle
E. Probst, (F)
E. F. Pullen, D.S.O.
J. H. Puntin
J. M. Purcell
J. S. Pym, D.C.M.

W. E. Raley
J. H. Ramsay, M.C. & Bar
C. W. P. Ramsey, C.M.G., D.S.O.
T. G. Randolph, M.C.
P. H. Raney
F. S. Rankin
G. Rankin
J. E. Ratz
W. B. Redman
E. W. Reed-Lewis
W. J. D. Reed-Lewis, O.B.E.

A. C. Reid
J. G. Reid, D.S.O.
R. H. Reid
G. E. Revell
G. Reynolds
C. C. Richards
A. A. Richardson, O.B.E.
C. E. Richardson, M.C.
C. W. B. Richardson
F. A. Richardson
S. S. Richardson
W. A. Richardson, M.C.
W. F. Richardson, M.C.
W. H. Richardson, M.C. & Bar
A. G. Riddell, M.C.
B. Ripley, C.B.E., D.S.O.
A. B. Ritchie, M.C., (F)
W. W. Ritchie
J. R. Roberts
A. K. Robertson
A. M. Robertson, M.C.
T. E. Robinson
L. B. Rochester
C. H. Rogers, M.C.
C. S. G. Rogers
R. P. Rogers, D.S.O.
O. Rolfson
J. M. Rolston, D.S.O., (F)
G. Romanes
H. M. Roscoe
J. T. Rose
P. E. M. Rosenorn
J. H. Rosher
C. F. D. Ross
G. W. Ross
F. G. Rounthwaite
J. C. Rowan
H. G. Rowley
A. V. Roy
T. D. Ruggles
F. C. Rust
F. S. Rutherford
C. C. Ryan, M.C.

R. T. H. Sailman
B. J. Saunders
R. G. Saunders, M.C.
W. L. Saunders
J. K. Scammell
A. N. Scott, M.C.
E. H. Scott
G. D. Scott
G. M. Scott
H. M. Scott
M. A. Scott, D.S.O., (F)
N. M. Scott
W. D. Scott
F. K. Searancke
H. V. Serson
E. R. W. Seymour
S. W. Shackell, M.M.
G. L. Shanks
C. N. Shanly
R. E. Shannon
G. W. Shearer, D.S.O. & Bar
O. H. Shenstone
H. W. R. Shepherd
N. C. Sherman
H. L. Sherwood
W. H. Shillinglaw
L. E. Silcox, D.S.O.
A. J. Sill
A. W. Sime
R. Simpson
H. B. Sims
A. F. Smith
A. P. Smith
D. A. Smith
D. R. Smith
R. S. Smith, O.B.E., (F)
W. R. Smith
W. W. Smith
E. S. Smyth
R. G. Sneath
T. D. Sneath, M.C.
R. Snodgrass
F. A. Snyder, (F)
R. Sohier, (F)
D. C. Spears
R. A. Spencer, M.C. & Bar
P. O. Spicer
A. R. Sprenger
H. Sprenger
G. Sproule
A. D. Stalker
E. A. Stanger
H. P. Stanley, D.S.O.
G. J. Staples
W. H. Stark
H. G. Starr
W. D. Staveley, M.C.
W. D. Stavert
C. M. Steeves
C. Stephen
G. E. Stephenson
E. W. Stern
W. F. Stevenson
A. Stewart
A. E. Stewart
A. G. Stewart
A. M. Stewart
H. W. Stewart
J. C. Stewart, D.S.O.
J. B. Stirling
R. A. Stirling
A. A. St. Laurent
G. P. Stirrett
D. H. Storms, M.C.
R. S. Stronach

J. C. K. Stuart
W. J. Stuart
D. M. Sutherland
J. R. S. Sutherland
H. L. Swan
W. G. Swan, D.S.O., (F)
C. J. Swift
J. A. Symes
C. F. Szammers, (F)

V. H. Tait
J. F. Tanton
H. W. Tate
A. J. S. Taunton, D.S.O.
F. W. Taylor-Bailey, M.C.
G. R. Taylor
A. Theriault
J. H. Thompson
G. O. Thorn
S. M. Thorne, M.C., (F)
L. B. Tillson, M.C.
J. A. Tilston
A. Timbrell
F. H. Tingley, M.C.
M. Tison
J. A. Tom
G. L. Tooker, M.C.
N. L. Tooker
T. L. Tremblay, C.M.G., D.S.O., (F)
J. H. Trimingham
H. L. Trotter, D.S.O.
G. R. Turner, M.C. & Bar, D.C.M.
J. A. Tuzo
A. G. Tweedie
J. O. Twinberrow
H. W. Tye, M.C.
W. G. Tyrrell, D.S.O.

W. P. Unwin
H. R. Urie, M.C.

C. P. Van Norman
F. W. Van Wart
G. E. Vansittart
E. Vinet
H. H. Vroom

H. W. Wagner
W. D. Walcott
S. M. Waldron
G. A. Walkem
T. M. Walker, O.B.E.
G. A. Wallace
H. D. M. Wallace
C. S. Walley, M.C.
N. J. Wallis
J. E. A. Warner, M.C.
P. R. Warren, O.B.E.
G. L. Watson, (F)
J. P. Watson
M. B. Watson
A. D. Watts
K. Weatherbe, M.C.
P. Weatherbe
O. Weeks
S. F. Weeks
W. R. Weidman
F. E. Weir
A. E. Welby
H. R. Welch
H. G. Welsford, M.B.E.
C. W. West
F. L. West
F. W. C. Wetmore
D. A. White, D.S.O.
J. A. G. White, D.S.O., M.C.
J. L. Whitside
D. Whittaker
A. A. Wickenden
A. W. R. Wilby, C.B.E.
S. C. Wilcox
W. P. Wilgar, D.S.O.
F. A. Wilkin, M.C.
J. B. Wilkinson
J. N. Williams
F. J. Willson
A. L. Wilson
C. P. Wilson
J. A. Wilson
J. C. Wilson
L. Z. Wilson, M.C.
N. Wilson
W. J. Wilson
W. T. Wilson, D.S.O., M.C.
A. Wimbles
H. S. Windeler, M.C.
R. H. Winslow
H. A. Wood, M.C.
D. H. Woollatt
A. N. Worthington
A. C. Wright
P. A. Wright
J. K. Wyman
L. W. Wynne-Roberts

A. A. Young
W. Youngman, M.C.
R. Yuill

(F) Foreign Orders.

Recent Graduates in Engineering

Congratulations are in order to the following Juniors and Students of The Institute who have recently completed their course at the various universities:—

McGill University

Honours, Medals and Prizes

Angel, John Bartlett, St. John's, Nfld.—B.Eng., (Met.); American Society for Metals Prize for Metallography and Thesis.
L'Allier, Lucien, Montreal, Que.—B.Eng., (El.); Honours in Electrical Engineering; British Association Medal; Montreal Light, Heat and Power Consolidated First Prize; The Jenkins Brothers Limited Scholarship.
McGregor, Douglas Robert, Sherbrooke, Que.—B.Eng., (El.); Honours in Electrical Engineering; Montreal Light, Heat and Power Consolidated Second Prize.
Paton, Charles Peter, Montreal, Que.—B.Eng., (Mech.); Honours in Mechanical Engineering; The Engineering Institute of Canada Prize (1934).
Pope, Francis Robert, Montreal, Que.—B.Eng., (Mech.); Honours in Mechanical Engineering; British Association Medal.
Rose, Alexander, Montreal, Que.—B.Eng., (Chem.); Honours in Chemical Engineering; British Association Medal.
Wadge, Norman Hilton, Winnipeg, Man.—B.Eng., (Mi.); Dr. James Douglas Fellowship in Mining Engineering.

Degree of Bachelor of Engineering

Beath, Lawrence Raymond, B.Eng., (Chem.), Regina, Sask.
Blair-McGuffie, Malcolm Hugh, B.Eng., (Chem.), Hayward's Heath, Sussex, England.
Brown, Ernest Frederick, B.Eng., (Mech.), Montreal, Que.
Burri, Henry William, B.Eng., (Mech.), Montreal, Que.
Christie, Robert Louis, B.Eng., (Mech.), Truro, N.S.
Cooper, William Everett, B.Eng., (El.), Moose Jaw, Sask.
Dobson, Richard Nesbitt, B.Eng., (Mech.), Montreal, Que.
Duncan, Gaylen Rupert, B.Eng., (El.), Fort William, Ont.
Dunlop, James Russell, B.Eng., (Mech.), Ottawa, Ont.
Ferguson, James Bell, B.Eng., (Mech.), Pictou, N.S.
Gunning, Merle Percy, B.Eng., (El.), St. Lambert, Que.
Houghton, John Ruse, B.Eng., (Mech.), Montreal, Que.
Ingham, Jason Harold, B.Eng., (Mech.), Montreal, Que.
Jeffrey, James Stewart, B.Eng., (Mech.), Vegreville, Alta.
Kazakoff, John, B.Eng., (El.), Kamsack, Sask.
Kimpton, Geoffrey Holiday, B.Eng., (Chem.), St. Lambert, Que.
Leahey, James Climacus, B.Eng., (El.), St. John's, Nfld.
Lockwood, Clarence Kingsley, B.Eng., (Met.), Montreal, Que.
MacKay, Ian Norton, B.Eng., (Mech.), Montreal, Que.
Morris, Harold Kempffer, B.Eng., (Mech.), Edmonton, Alta.
Mussen, Guy Aubrey, B.Eng., (El.), Montreal, Que.
Purves, William Franklin, B.Eng., (El.), Saskatoon, Sask.
Ransom, Rosmore Howard, B.Eng., (Ci.), Montreal, Que.
Reynolds, George Kenly, B.Eng., (Mech.), Montreal, Que.
Ross, Thomas Wilson, B.Eng., (Mech.), Hawkesbury, Ont.
Rowell, Lorne Archibald, B.Eng., (El.), Wapella, Sask.
Schear, Philip M., B.Eng., (Chem.), Montreal, Que.
Schofield, Robert John Graham, B.Eng., (Chem.), Montreal, Que.
Shortall, John Desmond, B.Eng., (El.), Montreal, Que.
Smith, Odric Henry, B.Eng., (Mech.), Montreal, Que.
Schnyder, Max, B.Eng., (Mech.), Montreal, Que.
Swift, John William, B.Eng., (Mech.), Montreal, Que.
Tatham, William Carlyle, B.Eng., (Mech.), Elora, Ont.
Thompson, Robert, B.Eng., (Met.), Lachine, Que.
Wigdor, Edward Irving, B.Eng., (El.), Montreal, Que.
Winn, James, B.Eng., (Mech.), Montreal, Que.
Wong, Henry Gee, B.Eng., (Ci.), Montreal, Que.
York, Fred Gilbert, B.Eng., (El.), Ottawa, Ont.
Zion, Alfred Bernard, B.Eng., (Mech.), Montreal, Que.

Degree of Master of Engineering

Clarke, George Frederick, B.Sc., (McGill Univ. '31); M.Eng., (Mech.), Ewarton, Jamaica, B.W.I.
Howe, Lawrence McLean, B.Sc., (Univ. of Manitoba '33); M.Eng., (El.), West Shefford, Que.

Degree of Bachelor of Commerce

Wisdom, Charles Stuart Cotton, B.C., Shawinigan Falls, Que.

University of Toronto

Degree of Bachelor of Applied Science (with Honours)

Bowen, John Alfred Clarke, B.A.Sc., (Ci.), Long Branch, Ont.
Finlay, Ruskin Reid, B.A.Sc., (El.), Toronto, Ont.
Hewitt, Robert, B.A.Sc., (Ci.), Toronto, Ont.
Howard, Albert Warren, B.A.Sc., (El.), Calgary, Alta.
Johnston, William David, B.A.Sc., (Ci.), Toronto, Ont.
Miller, Dudley Chipman Raphael, B.A.Sc., (Mech.), Toronto, Ont.
McMullen, William Francis, B.A.Sc., (El.), Toronto, Ont.

Degree of Bachelor of Science

Hornfelt, Harvey Andrew, B.A.Sc., (Ci.), Toronto, Ont.
Robson, William John, B.A.Sc., (Mech.), Toronto, Ont.
Shanks, Victor, B.A.Sc., (El.), Toronto, Ont.
Smith, Arthur James Edwin, B.A.Sc., (Ci.), Toronto, Ont.

Ecole Polytechnique

Honours, Medals and Prizes

Rowan, John James, Ottawa, Ont.—B.A.Sc., (Ci.); Honours in Civil Engineering.
Tasse, Yvon Roma, Montreal, Que.—B.A.Sc., (Ci.); Honours in Civil Engineering; Silver Medal offered by Lieutenant-Governor of the Province of Quebec; Bronze Medal offered by the Association des Anciens Elèves de l'Ecole Polytechnique.

Degree of Bachelor of Applied Science

Gregoire, Armand E., B.A.Sc., (Ci.), Montreal, Que.

University of New Brunswick

Honours and Medals

Brewer, Douglas Jared Brewer, Fredericton, N.B.—B.Sc., (Ci.); The Ketchum Silver Medal for the highest standing in Civil Engineering.
Smith, Wilfrid Ewart, Fredericton, N.B.—B.Sc., (El.); City of Fredericton Gold Medal for the highest standing in fourth year Hydraulics.

Degree of Bachelor of Science

Benson, Willard MacLean, B.Sc., (Ci.), Fredericton, N.B.
Bonnell, Alexander Robertson, B.Sc., (Ci.), Fredericton, N.B.
Brannen, Edwin Ralph, B.Sc., (El.), North Devon, N.B.
Coombes, David Eaton, B.Sc., (El.), North Devon, N.B.
Eagles, Norman Borden, B.Sc., (El.), Moncton, N.B.

Gibbons, James Fenton, B.Sc., (El.), Fredericton, N.B.
Huggard, John Harold, B.Sc., (El.), Norton, Kings Co., N.B.
Lilley, Ledford George, B.Sc., (El.), West Saint John, N.B.
Mackie, George Arthur, B.Sc., (El.), Saint John, N.B.
Sansom, Ralph Thomas, B.Sc., (El.), Campbellton, N.B.
Tweeddale, Reginald Estey, B.Sc., (El.), Arthurette, Victoria, N.B.
Webb, David Roland, B.Sc., (El.), Saint John, N.B.

University of British Columbia

Degree of Bachelor of Applied Science

Bell, Douglas E., B.A.Sc., (Chem.) Vancouver, B.C.
Davis, Ralph, B.A.Sc., (Ci.), Etzikom, Alta.
Sparks, Wilbur Hamilton, B.A.Sc., (Ci.), Vancouver, B.C.

Degree of Master of Applied Science

Lind, Walter J., M.A.Sc., (Me.), Sidney, B.C.

Queen's University

Degree of Bachelor of Science (with honours)

Darwin, Bascom Herman, B.Sc., (Ci.), Vancouver, B.C.
Meuser, Henry Lloyd, B.Sc., (Ci.), Regina, Sask.
Pequegnat, Jared Marc, B.Sc., (Ci.), Kitchener, Ont.

Degree of Bachelor of Science

Aman, Thomas F. Stewart, B.Sc., (El.), Belleville, Ont.
Bellamy, Keith Lacy, B.Sc., (El.), Niagara Falls, Ont.
Bonney, Albert Jay, B.Sc., (Mech.), Peterborough, Ont.
Clarke, Ross Eugene, B.Sc., (Ci.), Gananoque, Ont.
DeMocko, Gerald George, B.Sc., (El.), Fort William, Ont.
Ellsworth, Arthur Crayton, B.Sc., (El.), Ridgeway, Ont.
Hare, William Lester, B.Sc., (Mech.), Ottawa, Ont.
Preston, William Walford, B.Sc., (Ci.), Hamilton, Ont.
Rintoul, William Vance, B.Sc., (Mech.), Burk's Falls, Ont.
Soles, William England, B.Sc., (Mech.), Rock Island, Que.

University of Saskatchewan

Degree of Bachelor of Science

Upton, Virgil Stanley, B.Sc., (Mech.), Gregg, Man.

University of Manitoba

Degree of Bachelor of Science

Davidson, Arthur Campbell, B.Sc., (Ci.), Calgary, Alta.
Marshall, Lawrence James, B.Sc., (El.), Ashern, Man.
Pask, Arthur Henry, B.Sc., (El.), Zeneta, Sask.

University of Alberta

Degree of Bachelor of Science

Beach, John Edward, B.Sc., (El.), Turner Valley, Alta.
Herbert, Albert Cecil, B.Sc., (El.), Wilkie, Sask.
Stevens, Robert Leonard, B.Sc., (El.), Edmonton, Alta.
Weston, Norman Owen, B.Sc., (El.), Edmonton, Alta.
Woznow, John, B.Sc., (Ci.), Medicine Hat, Alta.

Degree of Master of Science

Sinclair, George, B.Sc., (Univ. of Alberta '33); M.Sc., Edmonton, Alta.
Williams, David Gabb, B.Sc., (Univ. of Alberta '33), M.Sc., Edmonton, Alta.

Nova Scotia Technical College

Honours and Medal

Wright, Charles Abbott, Halifax, N.S.—B.Sc., (El.); Honours in Electrical Engineering; The Alumni Medal.

Degree of Bachelor of Science

Berringer, Ormus Benjamin, B.Sc., (Ci.); B.Sc., (El.), Lunenberg, N.S.
Carson, James Russell, B.Sc., (Ci.), Pictou, N.S.
Miller, Alex Matthew, B.Sc., (Mech.) New Waterford, N.S.
Moores, Robert Vernon, B.Sc., (El.), Black Head, Baie de Verte, Nfld.
Shatford, Ralph Grant, B.Sc., (El.), Dartmouth, N.S.
Sutherland, James Gordon, B.Sc., (El.), St. Peters, P.E.I.

Royal Military College

Honours, Medal and Prize

Powell, Robert M., Ottawa, Ont.—Graduate R.M.C. '35; Highest awards of the R.M.C.; Sword of Honour for Conduct and Discipline; Governor-General's Gold Medal for the highest aggregate of marking during the entire four year course; The Engineering Institute of Canada Prize; The Toronto Branch of The Engineering Institute of Canada Trophy; the Province of Quebec Department of Public Instruction award; the Bexhill Cup.

ELECTIONS AND TRANSFERS

At the meeting of Council held on June 18th, 1935, the following elections and transfers were effected:

Associate Members

HAMILTON, Vesey Courthope, (Grad. R.M.C.), supt., Canada Cement Co. Ltd., Exshaw, Alta.

NELSON, Edward, engr.-in-charge, Northwestern Utilities Limited, Edmonton, Alta.

ROUSSEAU, Gabriel E., B.Sc., (Mass. Inst. Tech.), asst. to the Director General of Technical Education, Province of Quebec, also lecturer and asst. to the Dean, Ecole Polytechnique, Montreal, Que.

SHELDEN, William Leslie, Associate, (Working Men's Coll., Melbourne), designing engr., water supply section, works dept., City of Toronto, Ont.

TIMMINS, Wilbur W., B.A.Sc., (Univ. of Toronto), manufacturers' agent, 344 University Tower, Montreal, Que.

Juniors

*ATTENBOROUGH, Ernest A., (Central Tech. School), tracer, sewer dfting office, Dept. of Works, City of Toronto, Ont.

DAVIS, William Roe, Jr., B.Sc., (Univ. of Alta.), asst. engr., Calgary Power Co. Ltd., Calgary, Alta.

Affiliate

KING, John David, (McGill Univ.), manager, Detroit Stoker Co. of Canada, Montreal, Que.

Transferred from the class of Associate Member to that of Member

CROSS, Edgar Algernon, B.Sc. (Civil), (Birmingham Univ.), consltg. struct'l. engr., 25 Ferndale Ave., Toronto, Ont.

GARRETT, Julian, A.B. (Harvard Coll.), director, manager, and sec. treas., Northwestern Utilities Ltd., Edmonton, Alta.

Transferred from the class of Junior to that of Associate Member

*SHUTTLEWORTH, Wilbur Irvin, instr'man., engrg. dept., City of Ottawa, Ont.

Transferred from the class of Student to that of Junior

BUTLER, Howard Claude, B.Sc., (McGill Univ.), asst. to chief engr., Dominion Rubber Co. Ltd., Montreal, Que.

SEELY, Wallace Errol, B.Sc., (Univ. of N.B.), 1492 Bishop St., Montreal, Que.

Students Admitted

EAGLES, Norman Borden, B.Sc., (Univ. of N.B.), 110 Cornhill St., Moncton, N.B.

GIBBONS, James Fenton, B.Sc., (Univ. of N.B.), Bayswater, N.B.

LOCKWOOD, Clarence Kingsley, B.Eng. (Chem.), B.Eng. (Metal.), (McGill Univ.), 602 Cote St. Antoine Rd., Westmount, Que.

MACKIE, George Arthur, B.Sc., (Univ. of N.B.), 223 King St. East, Saint John, N.B.

ROWAN, John James, B.A.Sc., C.E., (Ecole Polytech., Montreal), 162 Friel St., Ottawa, Ont.

SANSOM, Ralph Thomas, B.Sc., (Univ. of N.B.), P.O. Box 614, Campbellton, N.B.

SMITH, Odric Henry, B.Eng., (McGill Univ.), 11 Melbourne Ave., Westmount, Que.

UPTON, Virgil Stanley, B.Sc., (Univ. of Sask.), Gregg, Man.

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*Has passed Institute's examinations.

Results of May Examinations of The Institute

A further report from the Board of Examiners, presented at the meeting of Council held on June 18th, 1935, certified that the following candidate, having passed the examinations of The Institute, has satisfied the examiners as regards his educational qualifications for the class of membership named:

Schedule B—For admission as Junior:
Ernest A. Attenborough......Toronto, Ont.

Some Problems of Transportation

Frederick A Gaby, D.Sc., M.E.I.C.

An address delivered before the Canadian Credit Institute, March 13th, 1935. (Abridged.)

Rail transportation is a vital necessity for the stability and growth of our social and economic system. The very existence and the economic structure of the Dominion of Canada were based upon adequate railroad communication between the east and west. British Columbia had written into the terms of the Confederation compact a clause binding Canada to "undertake the commencement simultaneously within two years from the date of the union (Confederation) of the construction of a railway from the Pacific towards the Rocky Mountains, and from such point as may be selected east of the Rocky Mountains towards the Pacific, to connect the seaboard of British Columbia with the railway system of Canada, and further to secure completion of such railway within ten years from the date of the union."

The government attempted to carry out its undertaking, but by the end of ten years only 264 miles had been constructed. The difficulties were tremendous, and the government was faced with bankruptcy if its then programme was continued. The solution eventually obtained was the contract with the Canadian Pacific Railway in 1881 for the construction of the remaining trackage of 2,600 miles which was ultimately accomplished in 1885.

About the year 1900 there was no railway problem in Canada, but shortly thereafter duplication of services was evident in the construction of additional railway facilities, financed largely upon government credit.

In a little more than fifteen years the whole railway situation passed from the position of manageable cost and moderate expansion to one of confusion and over-extension.

From 1900 to 1916 the railway mileage in Canada had more than doubled—from 17,500 to 36,000 miles. The five main railway systems were: Canadian Pacific Railway, Canadian Northern Railway, Grand Trunk and Grand Trunk Pacific Railways, National Transcontinental Railway, Intercolonial Railway; the latter two being government railways. The railways in Canada had a combined investment for road and equipment of about $2,550,000,000, of which $2,020,000,000 was invested in all railways other than the Canadian Pacific Railway. They later on became parts of the Canadian National Railway System.

The inability of the railways now represented by the Canadian National Railway group to meet their financial obligations and the demand for further governmental support, resulted in the appointment of a Royal Commission in 1916, whose reports recommended the nationalization of the railways then in difficulties. This recommendation was effected in the case of all except the Grand Trunk, and the government embarked upon a programme of nationalization. Further capital commitments of over $350,000,000 were undertaken between 1915 and 1921 in the consolidation, extension and equipment of the systems referred to. The Grand Trunk Railway became a part of the government systems on May 21st, 1920. This was followed in the next decade by an extraordinary and extravagant programme of railway building resulting in the duplication and triplication of services, particularly between the years 1921-1931, during which period over $550,000,000 was spent in this way (in the extension and improvement of railway facilities). The railway situation reached a chaotic state in 1931. Again the increasing obligations of the government on account of the national railways were causing much concern, and during this time a Senate Committee reported that the railway question was one of extreme urgency.

Following the recommendation of a special committee of the House of Commons in 1931 a Royal Commission known as the Duff Commission was appointed to inquire into the whole question of transportation in all its forms, and after nine months of inquiry and study, this Commission reached conclusions designed to secure co-operation of the privately owned Canadian Pacific and the National Railways, while preserving competition and separate administration of the two railway systems.

This was the position of the railway problem in 1934 and it is unchanged to-day. It is one of Canada's major financial problems—with 42,000 miles of railway supplying a population of only 250 per mile of track and a capital debt of the railways of Canada in excess of $4,400,000,000 of which over $3,000,000,000 is attributable to the Canadian National Systems.

The following are a few pertinent facts and figures which have a direct bearing on the problem under discussion:—

The total government and railway debt of Canada as at March 31st, 1934, was $3,986,000,000.

The proportion of this debt attributable to the Canadian National Railway was $2,320,000,000 or 58 per cent of the total government and railway debt of Canada.

The deficits of the Canadian National, from 1923 to 1933, inclusive, totalled $644,000,000, which sum considered in terms of taxation, are equivalent to 99 per cent of the total receipts from the income tax and 94 per cent of the total receipts from the sales tax.

During the same period the total gold production of all Canada amounted to $469,000,000 or less than three-quarters of the Canadian National Railway losses.

In 1919, the Canadian National interest charges on funded debt owing to the public and the government, amounted to $38,200,000; by 1923 they had risen to $65,200,000; in 1933 they totalled $92,500,000.

For the year ending December 31st, 1933, the Canadian government was obliged to meet a railway deficit of approximately $96,000,000. This amount was made up as follows:—

Net income deficit before interest	$ 3,552,286
Interest due public on long term debt	56,465,427
Interest on Dominion Government loans	36,034,141
	$96,051,854

The average Canadian family pays approximately $46.30 a year in taxation to maintain the Canadian National Railways.

Speaking in the House of Commons on January 28th of this year, the Honourable Mr. Manion, Minister of Railways and Canals, made a statement that merits the attention of every Canadian. Mr. Manion pointed out that the government books show that the Canadian National Railways are indebted to the Government of Canada (apart from guarantees) to the extent of $1,490,000,000. This includes capital investment and accumulated interest and other charges. About one-half of this amount went into the building of the Canadian National Railways as they stand to-day. The interest payable per annum on the portion of the debt bearing interest amounts to about $36,000,000.

In addition to this government debt, however, there is a long term debt owing to the public amounting to $1,255,000,000. Of this, some 75 to 85 per cent are bonds owned in England, the United States and Canada, which are guaranteed by the Dominion government. These entail an annual interest payment of $57,000,000. The credit of the country is directly involved in maintaining the integrity of this debt to the investing bondholders.

To relieve this situation two recent schemes have been suggested for the administration of our two great railway systems—one by Mr. E. W. Beatty and the other by the Honourable Mr. Euler.

Mr. Beatty suggests unification and the appointment of an administrative body to operate the joint properties for administration purposes; the administration to be free from political control.

Mr. Euler suggests that a holding company be formed by the government and that the corporate status of the companies remain unchanged, but the merged railways would be thrown into a single system, the net earnings being divided between the two units.

It has been variously estimated that savings will accrue from such unification or amalgamation of from $56,000,000 to $75,000,000 per annum.

Both plans are estimated to assure a greater net operating revenue to apply on the obligations of the Canadian National and to provide a reasonable return to the owners of the Canadian Pacific Railway.

The above is the position in which we find the railway systems to-day in regard to the enormous debt the government has to carry, and the provision for the annual deficit and interest out of taxation and otherwise.

The Duff Commission in its report on the transportation problem in 1932 stated that unless some effective plan is adopted "to secure the efficient and economical working of both railway systems, and thereby not only reduce the burden on the Federal Treasury, but improve the financial position of the privately owned railway, then the only course that would be left would be either to effect savings in national expenditure in other directions or to add still further to the burden under which the industries of the country are suffering by the imposition of yet further taxation."

We are now living in a changed world. The aftermath of the Great War not only changed the map of Europe, but the face of the whole industrial, commercial and financial world. New and very important factors have entered the transportation field to-day and there is a major problem in co-ordinating them.

In 1909 there were registered in Canada 4,700 motor vehicles: in 1915, 89,000; in 1930, 1,235,000.

The extent to which the motor car is competing with the railways can be appreciated from the large increase in passenger miles travelled in private automobiles, which increase has been in excess of 500 per cent from the year 1925, exceeding the railway passenger miles by 300 per cent, or at a ratio of 12,000,000,000 annual passenger miles to 3,000,000,000 on the railways, with the buses operating a smaller total of 250,000,000 passenger miles.

The passenger revenue of the Canadian railways has been progressively decreasing from $75,000,000 in 1923 to $31,000,000 in 1934. A large part of this loss is due to the passenger auto and only a comparatively small amount to the operation of buses.

As regards freight the motor truck is in aggressive competition with the railway. There are in Canada 150,000 trucks of which 88,000 are registered in Ontario and Quebec.

A secondary land transport system of highways has been constructed, whose mileage, capital cost and potential capacities approximate or exceed that of the railroads. The railroad faces a competitor which challenges its supremacy in the short-haul field.

In certain of the provinces, trucks are licensed under various classes. Of the 88,000 trucks in Ontario and Quebec about 2,000, including trailers, are in the business of common carriers. That is, they operate a general public trucking business over defined routes and usually between fixed termini. A second class is that of contract carriers having no definite route or schedule but which may, either within certain limits or in an unlimited area, make contracts to carry the goods of a particular shipper. With the present inadequate methods of enforcement, it is very difficult, if not impossible, to confine the truckers to the restrictions contained in their licenses and to the legislation under which they operate. Violations are the rule rather than the exception.

The Duff Commission estimated that the revenues of the common and contract carriers by truck amounted to over $30,000,000 per annum, and that of this amount $13,000,000 was taken from the railways.

The tariff structure of the railways has permitted the truck to compete within a limited range. Railway tariffs have beeu built upon a social basis rather than upon an economic one, rates being determined upon a commercial value and not upon the cost of service based on weight, bulk and distance travelled. Thus the railways must, for the good of the country, carry grain, coal and like commodities over long distances in carload lots, at actually less than average cost, and as a result, they must depend upon short hauls of the more valuable commodities to make up this loss. The very character of the truck competition, which limits its profitable operation to short hauls in small quantities, is enabling the trucker to carry a large percentage of the L.C.L. freight originally carried by the railways. Although the L.C.L. freight forms only 2.5 per cent of the total tonnage carried by the railways, yet it represents more than 10 per cent of their total revenues.

Thus the trucks take the cream of the traffic that has been relied upon by the railways to compensate for the less-than-cost handling of certain commodities which must be hauled cheaply in order to maintain our economic system and our position in the markets of the world.

Motor traffic has been heavily subsidized by governments through enormous programmes of improved road construction. It is variously estimated that the highway system of Canada has cost from $800,000,000 to a billion, with annual expenditures in the past running from $60,000,000 to $90,000,000, against a collection of revenue from motor vehicle operation of approximately $40,000,000. The difference must be charged to capital account, or made up out of the general fund provided by taxation.

It is recognized that the motor truck and bus have an economic field in the world of transportation, that they are here to stay and cannot be taxed out of existence or legislated into oblivion. It is their unregulated competition in fields that are not economic that causes the waste and increased costs to industry. It cost trucks carrying merchandise for over 500 miles 4 to 5 cents per ton mile, whereas the railways could carry it for less than one-third of this cost. In order to meet railway competition, trucks very often accept business at less than cost, without due knowledge of all the factors entering into their financial obligations.

At present, due to this unregulated competition, national economy, so essentially dependent upon a solution of the present railway problem, is unhealthy. The truckers themselves realize this, and it rests with public opinion, exerted in the right direction, to bring about a solution.

The time must come, if prosperity is to be enjoyed by this country, when, through the elimination of the weaker, road monopolies are established, or some properly enforced regulations are set up so as to put an end to the present extravagant and wasteful competition from this source.

It has been truly stated that under present conditions, freight, which was once hauled by the railways which paid taxes to the government, is now shipped over highways which tax the government.

The railways have to meet another problem in the subsidized transportation provided by our waterways—an important competitor which is not required to pay tolls or other equivalent share of the expense of providing, maintaining and operating the canals by which the great waterways from the Atlantic to the head of Lake Superior are made available for the transport of merchandise. To illustrate the importance of competition from this source, take the changed conditions in transportation brought about by the opening of the new Welland canal in 1930, which permitted the operation of greater draught boats between Lake Erie and Ontario. Although the tonnage handled on the St. Lawrence and Sault Ste. Marie canals remained about the same over the years 1930 to 1934, the tonnage on the Welland canal increased by over 50 per cent, or from 6,000,000 odd tons per annum to 9,000,000 odd tons per annum. What was gained by water shipping was lost to the railways.

Recently bills have been submitted to the United States Congress providing for a closer co-ordination of rail and water traffic, with a recommendation for through rates and charging of tolls. This matter should receive the serious consideration of our Federal government in dealing with the co-ordination of such service with land transportation.

In air transportation we enter a field of activity, the importance, general magnitude and trend of which are but little appreciated except by those who are actively engaged in this work.

Last year, the air lines of the United States operated approximately 200,000,000 passenger miles.

Including five hundred and forty-three pilots, there were over six thousand persons upon the payrolls of the United Air Lines Company of the United States. This company last year served three hundred thousand meals in the air, requiring a staff of one hundred and fifty stewardesses. The passenger who leaves New York for Los Angeles, San Francisco or Seattle, is served with four meals aloft.

It is interesting to observe that a questionnaire recently sent out by the United Air Lines to six hundred and thirty business firms making enquiry respecting their use of and attitude towards air travel, received replies as follows:—

To the question "Do you travel by air on business" 53 per cent answered "yes." To the question "Do you encourage your sales staff to use air transportation" 40 per cent said "yes." This contrasted with but 21 per cent in 1931. In reply to the question "Do you intend to make greater use of air travel in the future" 50 per cent replied affirmatively.

Railroads are devoting increased attention to air transportation not only because of the possibility of having to cope with that form of competition, but also in order to secure a better co-ordination of air and rail services. In its prime function of supplying nation-wide transportation, the railroad companies may have to reach out into remote areas where it would be economically impossible to supply any other form of transportation than that by air. The northern areas of the Dominion, coming, as they are, into increasing economic importance, have already been receiving the advantages of air travel and transport—a service of great worth to mining and other activities in isolated territories where other forms of transportation would be financially impossible.

A dispatch from Edmonton in the middle of January stated that the chief pilot for Canadian Airways, Limited, had just completed a noteworthy winter flight with furs and mail from Aklavik to MacMurray, a distance of 1,462 miles, which he accomplished in two and a half days. The flight was the more remarkable because at this season of the year, with only four hours of arctic twilight, the pilot, Mr. Walter Gilbert, made the jump from Aklavik to Fort Norman, 730 miles, in less than four hours.

Northern Canada is recognized as lying along the logical airway from Europe to the Far East. The hope has been expressed that Canada will not rest content with simply providing airports, but that she may reach out to establish regular aeroplane routes supplied with Canadian planes and manned with Canadian pilots.

It is claimed in a recent survey of air transportation made by United Air Lines that travellers by air in the United States pay an average of 2½ cents less per mile, and at the same time travel from 40 to 50 miles an hour faster than is the case in other countries. The average fare in the United States is said to be 6 cents per mile as contrasted with 8½ cents per mile in Europe, and with what is frequently a 10-cent per mile rate in other territories.

The year 1933 is the last one for which complete Canadian government aviation statistics are available, but a few 1934 figures have been issued. A number of the classification headings, such as aircraft miles, flights, hours and passengers, show a decline from 1931, although Canadian Airways' 1934 operations show a marked recovery from the 1933 low. On the other hand, freight and express and mail carried show substantial increases; thus the freight and express carried in 1931 was 2,372,000 pounds; in 1933 it was 4,206,000 and in 1934 approximately 13,500,000 pounds. Truly a remarkable showing. In 1931 the mail carried was 470,000 pounds; in 1933, 539,000 pounds; and in 1934, 626,000 pounds. At the end of 1933 there were in Canada 405 private air pilots, 474 commercial air pilots, and 403 air engineers, and 49 private aircraft and 296 commercial aircraft. Several new air transportation companies have begun operations in the northern mining districts and are showing quite remarkable results.

At the present time practically all large transportation concerns are devoting attention to the study of such pertinent factors as exert individual and collective effects upon the problems of transportation in order that a definite and clear course may be selected for the progressive administration of railroad and other transportation facilities.

Such a course is the more essential at this time because practically every railroad has been working along the lines of strictest economy and avoiding, so far as possible, large capital expenditures. These special economies have been exercised in order to keep existing equipment in the best possible repair. The time, however, is approaching when new equipment must be obtained, and in this connection real wisdom is required. New ideas will have to be most carefully scrutinized and evaluated. There is not capital available for non-productive equipment.

It is well recognized that all forms of transportation are essential and have their economic place in the transportation world, but they do not always remain in their proper place. They extend into the legitimate field of the railways. It is the unregulated, indiscriminate competition of trucks and other forms of transportation that is increasing the cost of transportation to industry and the people. You cannot have duplication and multiplication of services in the same field and expect to have economy. The loss due to unwise operation ends in bankruptcy, and such financial loss has to be borne by some industry or individual.

In the last twenty years one of the most important items of cost in transportation has been obsolescence, due to the rapid advance of the art, and this applies especially to the motor vehicle and the aeroplane.

In the United States legislation has been recently submitted providing for transport regulation by governmental authority to be applied to co-ordinate agencies of transportation.

Three principal developments in the field of railway passenger service have already had a stimulating influence on traffic, namely, streamlined trains, air-conditioning and increased speed. By the end of 1935 it is expected that six thousand passenger cars will be air-conditioned.

Many records of increased speed in passenger and freight services have been set up in the past year.

The year 1934 definitely put certain railways in the United States in the truck business, and pick-up and delivery service is now an integral part of the railway operations. Fast merchandise train service, with overnight delivery, is now provided to all points up to 300 miles, involving better and more closely supervised service.

The history of transportation reveals the fact that when Canadians launched upon the construction of a second and then a third transcontinental railway system, with all that was involved in competition and in losses incident to wasteful duplication, the three transcontinental railways were headed for economic distress. The railways fully recognize the right of legitimate competition. Where it is conducted on a reasonable and fair basis, the railways, no doubt, will continue in the future, as they have done in the past, to meet such competition so far as it is economically possible. They have no inclination to proceed unjustly upon any coercive or destructive lines. They look rather to attainment by means of intelligent co-operation and just regulation.

Electrical Developments in Russia

Some further information on the ways in which electricity supply is being developed in Russia under the Second Five-Year Plan is given in recent issues of "Elektrichestvo." Broadly speaking, the object is to increase the annual output from the 13,400,000,000 kw.h. of the last year of the First Five-Year Plan to 38,000,000,000 kw.h., and to produce 24,500,000,000 kw.h. of this total in "regional" as compared with "industrial" stations. If this is achieved, it is estimated that Russia will take the first place in electrical output among European countries by 1937, and will only be outdistanced in the world by the United States.

This development will be based on the use both of local fuel supplies and of water power. The Stalinogorsk and other stations in the Moscow district will be operated on brown coal, and their annual consumption is expected to rise to 2,472,000 tons, as compared with 597,000 tons in 1933. Coal from the Ural will be burnt to the extent of 1,728,000 tons at Perm and Chiliabinsk, while the station at Cherenchevsky is being designed to use East Siberian coal. It is also proposed to use oil-shale from the Kashira field for the first time in the extended Samara station and at Saratov, while the employment of Gdovsk shale in the Leningrad district is being considered. A deciding factor in this connection may be the utilization of the ash, which is produced in large quantities, for industrial purposes. A large number of stations are also being built to utilize peat, including those at Gorkovsky, with an output of 201,000,000 kw.h., and at Shatura, with an output of 180,000,000 kw.h.

As regards water power, twenty-five stations with an aggregate capacity of 2,000,000 kw. are being built. These include one at Gizeldon in the Caucasus, with a capacity of 22,000 kw. and an operating head of 312 m., and one at Nijnisvirsk, with a capacity of 96,000 kw. and an operating head of 19.5 m. The former is equipped with Pelton, and the latter with Kaplan, turbines. A large station will be that at Verchnisvirsk, on the river Svir, with a capacity of 144,000 kw. This will be used to supply the Leningrad district. Plans are also being prepared for the construction of a station on the river Cherchik, in Central Asia, which will have a capacity of 170,000 kw. and will be used to supply the works of a chemical combine. Another station of some interest is that at the outlet of Lake Sevan in Armenia, which is at 2,000 m. above sea level. The most important hydro-electric schemes are, however, those on the river Volga, where stations are to be constructed at Yaroslav (100,000 kw.), and at Balachna (200,000 kw.), and on the river Kahma, where a station with a capacity of 360,000 kw. is to be built at Perm. These and other stations form part of the plan for improving the navigation of the Volga, Svir, Dnieper and other rivers, and for developing the irrigation facilities. It is estimated that the annual output from hydro-electric stations will eventually reach 4,800,000,000 kw.h., the equivalent of 3,000,000 tons of fuel.—*Engineering.*

CORRESPONDENCE

To The Editor of the "Journal,"
Engineering Institute of Canada,
2050 Mansfield Street,
Montreal, Que.

Dear Sir:—

Now that the period has expired during which essays on the "Consolidation" problem may be submitted for the Past-Presidents' Prize, I would like to present to the membership, through the medium of The Journal, a memorandum on this question which I have prepared after much thought and much consultation with members throughout the country. This memorandum is also being presented in a spirit of co-operation to the Committee on Consolidation for their study but is being sent to The Journal in order that it may reach the whole membership and prove to them that alternative schemes to that broadcast by Mr. G. M. Pitts are not only possible but have been present in the minds of members in various parts of the country and are actually expressing themselves in simultaneous and unconnected movements in the different provinces. While I can connect no names other than my own with the following remarks, they do certainly arise out of numerous discussions with individuals of all shades of opinion in as many of the Branches as it has been my privilege to visit.

Yours very truly,

(Signed) P. L. Pratley, m.e.i.c.

Memorandum

Any serious effort to solve the problem presented by the existing duplication of engineering organizations in Canada must be based upon the recognition of certain fundamental facts which may perhaps be expressed for present purposes as follows:—

1. It must be recognized that only to a very limited extent is engineering a profession in the proper sense of that word, and that comparisons with the other vocations where the degree of professionalization is very different, are at least misleading and are potentially dangerous. Admittedly the meaning of "profession" may be revised or redrafted or stretched to various degrees, depending on the object in view, but basically, everybody knows that the essence of the idea is the personal contact between the "professor" and his client, whether he be lawyer, doctor or dancing-master. A considerable percentage, probably a large majority and possibly an increasing majority of engineers, particularly in the cities, are and will remain employees of corporations and industrial firms. These represent what might be termed the capitalistic edge of the wide field of engineering. On the other hand, in the provinces as distinct from the cities, an increasing percentage, under the socialistic tendencies of the times, are becoming employees of the state. To the former the provincial organizations have no appeal whatsoever and the licensing idea is totally inapplicable. By the latter the provincial organizations are regarded, whether consciously or not, as a type of trade union in no sense valuable to the public and only useful to the engineer as they limit the number of entrants or applicants for employment.

2. It must be recognized that at least two very different and distinct motives operate toward the formation and continuance of engineering societies, namely:—(*a*) service to and among engineers themselves—and (*b*) service to, and responsibility toward the public or private client. Item (*a*) postulates an organization of engineers which is mutually educative, which by means of meetings, papers, lectures and other forms of collaborative effort can increase the circulation of technical information, make available to the many the experience of the few and so raise the general standard of knowledge and ability. Item (*b*) postulates a system of protecting the public from incompetent or inexperienced individuals seeking their confidence upon false or insufficient claims to qualification: a system whereby the public are assured, as far as is humanly possible, that the engineer with whom they are dealing and upon whose advice or ability they are relying, is qualified by training and experience to assume responsibility for engineering works which involve public safety or which minister to public needs.

3. It must be recognized that while item (*a*) above may well be a national affair calling for a Dominion-wide organization, item (*b*) is by force of circumstance provincial in its strictly legal aspects. There is every advantage in making (*a*) national and no advantage in overemphasizing by undue or deliberate differentiation the necessity of a legal provincialism in (*b*).

4. It must be recognized as desirable that the element of compulsion be as far as practicable removed. Engineers must be attracted, not compelled, to join the National Institute and only a certain few whose responsibility to the public may be regarded as demanding it should be compelled to apply for a license to practise and show qualifications therefor.

Before dealing specifically with the existing state of affairs and the possibility of its transformation, there will be first presented in a general way the organization which from a practical viewpoint seems nearest to the achievable ideal. By practical viewpoint is meant that viewpoint which recognizes instead of disregards the four statements above written. The organization herein set forth involves the minimum of disturbance within the existing societies, the least seeking for new powers, the removal of the undesirable feature of 'compulsion' indiscriminately applied, the opportunity for a definite raising of the standard and status of the licensed engineer, a policy of encouragement for younger engineers to fit themselves for advancement, and most important perhaps, the elimination of the double set of fees.

For the national organization, concerned with the dissemination of knowledge, the welfare of the engineer technically, socially and to some extent financially, and with the wider contacts between engineering and public policies, the present E.I.C. seems logically to be the best fitted medium, subject probably to some interior development in the way of decentralization. This body would endeavour to enrol within its membership all persons employed or employing themselves in technical engineering work insofar as all such could either help, or be helped by, others of similar or related interests within the broad field of engineering. The general requirements for admission to the various grades of membership or associateship would be set up by the members themselves acting through their elected national council, leaving some leeway possibly for interpretation by the provincial divisions of the

National Institute who would be the active operating units and who would thus control admissions and elections. Each provincial division under its vice-president and its provincial council would include a licensing committee, either appointed or elected as may be arranged and which would administer the local act, serving exactly as the council of the present Provincial Association or Corporation. This Licensing Committee would deal, not only with members of the National Institute, but with all other engineers who by law or by choice came under its jurisdiction in respect to licensing, just as the existing provincial councils do. Under this Provincial Licensing Committee would come, as part of the duty of administering the act, the matter of issuing licences to engineers wishing to practise in direct contact with the public, i.e. consulting engineers in private practice, chief engineers of corporations selling materials, machines, facilities or services to the public, chief engineers of public service bodies, commissions, or boards, and heads of departments doing engineering work for municipal, provincial and federal governments (as far as the law permits). Such engineers and *only such* should be required, in consideration of their direct responsibility to the public to be licensed by law and such licences should be a real assurance that the possessor is trained and qualified by experience to practise in some definite field or fields of the profession. The qualifications should definitely include corporate membership in the national institute, or at least an acceptance from that institute that the engineer in question is fully qualified therefor, or in the case of a foreigner, seeking a temporary licence, equal standing in his own national body. The holding of this provincial licence by an engineer in such practice or positions as those just outlined would be the *only compulsory* feature in the whole organization.

Other fully qualified engineers wishing to do so would be allowed to register with the Provincial Licensing Committee, which procedure would save both time and trouble to themselves in the event of their being promoted or moved to a position requiring a licensed incumbent, or setting up in private practice.

Similarly, young graduate engineers wishing to do so, would be allowed to register with the Provincial Licensing Committee as having qualified in part, and having commenced to acquire experience. Such graduates, having ambitions toward private practice or advancement to positions requiring licensed engineers, would thus also save themselves time and trouble later on.

Both Registered Engineers and Graduate Engineers would be voluntary listees with the Committee and would only be charged nominal rates, and would enjoy a certain status possibly useful in applying for employment. When in the course of events either a registered engineer or a graduate engineer applied for a licence in some special field, such licence would be issued as a matter of course to the former and after investigation to the latter, when they would become liable for the extra fee as a Licensed Engineer. The graduate engineer might reasonably be required to become a corporate member of the national body, if not already one before being eligible for a licence, but certainly should be required to show that he was so qualified, as none but corporate members and those able to qualify for corporate membership should be licensed.

There would thus appear under the Provincial Licensing Committee lists of Licensed Engineers, Registered Engineers, and Graduate Engineers. It is not intended that these titles should be used as letters after the names of individuals, although they should appear on letterheads and possibly on plans, and the lists should at all times be accessible to the public. As to fees, the Licensed Engineer would, naturally, have to pay annually in addition to his regular Institute fees an amount set by the Provincial Division, but preferably uniform all over the country, and not likely in excess of ten dollars. The merely registered engineer and the graduate engineer could only be charged nominal additional sums as the service is only slight and the advantage more a matter of personal opinion. Possibly two dollars would be reasonable. Fees would be paid to the Provincial Division of the National Institute, the part belonging to the Licensing operation being retained by the Provincial Division together with a certain proportion of the Institute membership fees, and a pre-determined portion being remitted to National Headquarters. Fees from licensed engineers who are not corporate members of the National Institute should be substantially higher than the additional amount charged to members, but should not be more than the total fees payable by corporate members, and no part of this fee should find its way to the National Institute headquarters.

As to the accomplishment of this new consolidation and the transition from the existing conditions, and the transformation of the existing Societies, the principal requirement is the "will." If the "will" be reasonably unanimous and be founded on sound conceptions of the purpose and basis of consolidation, then the "way" will become relatively easy. There may undoubtedly be certain difficulties in some quarters. There may be entailed in some provinces a certain surrendering or realignment of present powers possessed, or apparently possessed, by the existing Provincial Corporations. For instance, those Corporations which hold that no one can be an engineer apart from the possession of a provincial licence will, of necessity, surrender this extreme and logically untenable position in favour of the logical attitude that a certain well defined group of engineers should definitely qualify for and receive licences as a protection to the public. Furthermore, the idea must be definitely discouraged that any association of engineers whatsoever may be used as a means of increasing financial remuneration at the public expense, on a power basis rather than a merit basis. It is also possible that the question of mining engineers will become serious in some provinces, but the provisions above outlined do not necessarily demand that all licensed engineers belong to the National Institute, and it would be quite practicable to permit mining engineers to substitute the C.I.M.M. for the National E.I.C.

Many details, naturally, are not referred to in this brief presentation, and some important matters still remain to be worked out, but the machinery exists for setting up the Provincial Divisions of the E.I.C. Some development of the E.I.C. in the direction of decentralization and provincial autonomy has already been acknowledged as overdue by most of the committees and thoughtful students of the Institute's future; in some provinces the councils of the Provincial Associations are at present almost identical with the elected officials of the E.I.C. from the province, and furthermore a spontaneous movement is noticed toward identity of personnel as between the Association Council and the representative committee of the Institute in that province. Arrangements could readily be made for non-interruption of existing activities, non-interference with existing lists of licensees, retention of provincial balances in the hands of Licensing Committees acting as successors to the present Association councils. It is quite possible that alterations to some of the existing acts would ultimately be required, but with the co-operation of the present associations there would not seem to be any overwhelming reason why the scheme of consolidation could not be implemented provisionally and the alteration in the acts delayed until two or three years of experience had been obtained. In any case, the difficulties of transition are bound to be much less than in some of the schemes which have been presented for consideration. The fact that so much of the idea of compulsion would be removed and that one fee only would be exacted from any engineer, would assist greatly among the great body of engineers in making it not only possible but easy to overcome the seeming difficulties, the existence of which is bound to be referred to by those not initially favourable to this present proposal.

The proposal, as here outlined, has in addition to these two advantages the further value that the Institute as a national body can retain its primary function, which is the dissemination and interchange of technical knowledge, and keep open its doors to all those worthy contributors to the progress of engineering who may never reach the professional status, and yet provide fully for all reasonable demands regarding licensing, but definitely on the basis of protection to the public.

P. L. P.

OUTLINE OF PROPOSED ORGANIZATION

NATIONAL E.I.C.
General Council, and Headquarters
Pres., Secy., Editor, Hon.-Treas.

- Hon. Members
- Provincial Division
  Provincial Council
  V.P., Prov. Secy.-Treas. and Registrar*
  - Licensing Committee**
    Lists of Licensed Engrs.
    Registered "
    Graduate "
  - Other Committees
  - Branches in Prov.
    - Members
    - Assoc.M.
    - Jrs.
    - Students
    - Affil.

*The Provincial secretary-treasurer will be registrar.

**The committee, if elected, chosen from and by licensed engineers, whether members of Institute or not.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

New Ford Foundry

On Friday evening, March 29th, 1935, members of this Branch were guests of the Ford Motor Company of Canada. Dinner was served to about eighty persons, including newspapermen and members of Ford's staff.

H. J. Coulter, A.M.E.I.C., chairman of the Branch, extended his thanks to the Ford Motor Company for its kind invitation.

Mr. Wallace Campbell, president of the Ford Motor Company of Canada, spoke a few words welcoming the engineers and commented on the benefits to the automobile industry derived from this profession.

Mr. Coulter introduced Mr. J. S. Beaumont, chief chemist for Ford Motor, who presented a short paper on the "New Ford Foundry."

This foundry is designed for the casting of Ford crank shafts. The metal making up the charge is all very carefully weighed and dumped into the electric arc furnace, where it is kept at a temperature of 3,000 degrees F. for eighty-two minutes. The entire furnace which is built on a cradle is then tipped and the molten metal is run off into ladles and then into specially prepared moulds. Each mould is made up of sixteen separate moulds, which when locked together will form four complete crankshafts. In the making of these moulds the variance permitted is thirty thousandths or approximately 2/1000 per unit mould.

This new crank shaft of cast alloy steel is better than the old type, because like cast iron it absorbs some of the vibration. It will withstand a twisting strain of 88,000 pounds which is ten times that actually used. In a test run to destruction with the centre bearing 1/32 inch out of line, the new cast shaft ran seventy hours as against forty-five hours for the forged one. There are fewer machining operations on the new shaft as only nine pounds of metal has to be removed as against twenty-four pounds on the forging.

Mr. Beaumont explained that this theory for the better qualities in the new cast crank had to deal with the "fluidity" of the crystal about which very little is understood at the present time.

The group then adjourned to the foundry where they had the opportunity of seeing the metal poured from the furnace and the detail connected with the making of the cores.

Lakehead Branch

Geo. P. Brophy, A.M.E.I.C., Secretary-Treasurer.

The Lakehead Branch of The Institute expressed its appreciation of one of its oldest members and the high esteem in which he is held as a citizen and a member of the engineering profession when it tendered a complimentary dinner to its chairman, J. Antonisen, M.E.I.C., on Friday, April 12th last.

J. Antonisen, M.E.I.C.

The dinner was given in the Garrison Officers' Mess at Port Arthur through the courtesy of the Commanding Officer and Officers of the Lake Superior Regiment, and our forty members and Branch guests enjoyed an excellent dinner in surroundings which combined to make the occasion one which peculiarly suited the purpose of honouring the guest of the evening. Altogether it was an enjoyable event and one which marked a spontaneous tribute to the engineering services rendered by Mr. Antonisen for many years as city engineer of Port Arthur, a service which was terminated at a loss to the city on March 1st, 1935.

Representatives of the Law Society, the Dental and Medical Associations, the Surveyors, Public Utilities, Power and Paper Interests, Railways and the Architects were among the guests of the Branch and all of these, in addition to engineering members, united in paying their respects to the man, the citizen and the engineer, and in wishing him continued success in his next field of endeavour.

P. E. Doncaster, M.E.I.C., as vice-chairman of the Branch, presided, and outlined the broad academic and engineering foundation on which Mr. Antonisen's professional career was based. He expressed the sentiments of all present in the statement that Canada would always welcome engineers from Norway or any other land who brought with them the high cultural and ethical standards which the guest of the evening combined with a sound engineering training and practice.

Mr. Antonisen replied to the many complimentary references to him in his own inimitable way and manner and, if possible, heightened the feeling of loss which the community and the engineering circle of the Lakehead Branch has sustained in the breaking of a long and happy association.

The annual meeting and election of Branch officers is scheduled for June 4th, 1935, at Fort William, and there is much promising timber in the younger members of the Branch from which to choose a strong executive.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

Bulk Handling

The Hamilton Branch of The Institute held their regular meeting at McMaster University on May 14th, 1935, to hear Mr. J. Farley, of the Link Belt Company, discuss the important subject of "Bulk Handling."

Mr. Farley stated that, with the development of the anti-friction idler, designers have reduced the power required in horizontal drives and belts to 3/5 the figure formerly necessary; the direct outcome, of course, was lighter belts, faster drives, etc. Distributing ploughs, shuttles, and trippers will now place belt-carried materials exactly where required.

He described in some detail uses of various types of general handling equipment including ship hoists, elevators, screws and chain belt equipment. Ship hoists, he stated, are now in large measure replacing elevators. Screws are extremely useful in handling non-abrasive materials. Some modifications in the former design of chain link conveyors have greatly improved their efficiency and lowered maintenance charges.

Mr. Farley then showed a motion picture of the operations at the Marblehead Lime Company of Chicago which was enjoyable in that the audience could view the interesting operations of crushing, screening and calcining without the atmospheric dust disturbances usually so troublesome in visiting the scene of such operations. Several technical points discussed by the members were explained by Mr. Farley.

A hearty vote of thanks was accorded Mr. Farley for his kindness in preparing so interesting a paper upon a broad subject. The meeting adjourned, and refreshments were served in the McMaster Chemical Laboratory.

Attendance, 40.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

Newsprint Paper Machines

This was the subject of a talk given by Mr. James O'Halloran, A.M.E.I.C., of the Anglo-Canadian Pulp & Paper Mills Limited, Quebec, at a meeting of this Branch held on March 4th, 1935.

Mr. O'Halloran's lecture was illustrated and for that reason the subject cannot be easily summarized; however, the main purpose of the speaker was to outline some of the principal operating and mechanical features of a modern high speed newsprint machine. This was done in a very able manner and the audience was greatly interested.

Short mention was made of mechanical and chemical pulp processes, attention was drawn to the fact that it requires approximately 1¼ cords of wood to produce one ton of newsprint paper.

The speaker then described a complete paper machine, and in concluding said that the last few years have been such difficult ones for the Canadian paper industry, that they have caused very careful studies to be made of the paper machines with the idea of increasing their operating efficiency and their speeds. Increased production without increased investment in equipment is a definite means of lowering production costs and this has been accomplished in a great many cases. Machines which five years ago had a maximum speed of 900 feet per minute can now successfully operate at 1,200 feet per minute due to careful study and adjustment with only minor changes in equipment.

Every part of the machine is receiving the closest attention at the present time, and it is hoped that the results will be faster and more efficient machines will help to lower manufacturing costs to a point where a profitable operation may be expected.

Saguenay Branch

J. W. Ward, A.M.E.I.C., Secretary-Treasurer.

PAPER MAKING

On Friday evening, May 10th, 1935, S. J. Fisher, M.E.I.C., gave a paper on the subject of "Paper Making, Ancient and Modern," before a meeting of fifty-two members and guests.

The speaker commenced his address by giving a brief history of the art of paper making. Before the first paper was made by the Chinese about 120 B.C. stone and bronze tablets were used, followed by parchment made from the skins of animals, and papyrus which was made by moulding or pressing the pith of a reed.

Paper may be described as a web, formed of strands of vegetable fibre first separated then recombined. This process was performed by the first paper makers, by breaking down wood or other vegetable matter under water. After obtaining a sufficient quantity of the mixture of fibre and water, a screen or mould was dipped into it, brought up and allowed to drain. A mat of interlocked fibre was left on the screen which was allowed to dry. The surfaces were smoothed by rubbing with stones.

The art spread slowly from China, reaching Bagdad about 793 A.D. and Morocco in 1100. It was introduced to Europe about 1390, reaching England by 1494 and America in 1690.

The hand mould process with improvements to moulds and fibre processing, continued to be the only manner of paper making until 1800 when the first developments were begun on continuous sheet machines.

Present day newsprint consists of 20 per cent to 25 per cent of sulphite pulp and the remainder ground wood pulp. Sulphite pulp gives the paper the strength required and the ground wood pulp gives it the high speed printing qualities. The best wood for newsprint is spruce with the addition of a small percentage of balsam.

The paper which was well illustrated with slides proved to be very interesting, and a hearty vote of thanks was tendered the speaker.

* * *

Immediately following the reading of the above paper, the members of the Branch held a meeting to discuss the proposal of G. McL. Pitts, A.M.E.I.C., regarding the amalgamation of The Institute with the various provincial associations of professional engineers. After some discussion a committee consisting of Messrs. H. R. Wake, A.M.E.I.C., G. F. Layne, A.M.E.I.C., J. Shanly, A.M.E.I.C., and H. B. Pelletier, A.M.E.I.C., was formed to make a further study of this proposal, and to prepare a motion to be placed before the next meeting. This motion, subject to the approval of a majority of the members, will take the form of an expression of opinion of the Saguenay Branch regarding the proposed amalgamation.

There being no further business the meeting adjourned.

The Late D. N. Dunlop, O.B.E.

Mr. D. N. Dunlop, O.B.E., founder of the World Power Conference, died on May 30th, 1935, after a short illness.

Born in Ayrshire, Scotland, in 1868, Mr. Dunlop served his engineering apprenticeship in Glasgow, and in 1896 became connected with the Westinghouse Company, retaining this connection until 1911 when he was appointed the first organizing secretary of the British Electrical and Allied Manufacturers' Association (B.E.A.M.A.), holding the position of director of that body until his death.

Soon after the war Mr. Dunlop conceived the idea that the engineers and scientists whose inventions had been so powerful in destruction, should lend their great talents in the rebuilding of the world.

As a result of his efforts, on June 30th, 1924, the Prince of Wales opened the first World Power Conference in the presence of representatives of about forty countries. From this conference grew a permanent organization continuing the work begun in 1924, so that during the past eleven years the second plenary World Power Conference has been held in Berlin and sectional meetings in Basle, London, Barcelona, Tokyo and the Scandinavian capitals, while the Chemical Engineering Congress of the World Power Conference will take place in London next year.

The World Power Conference has now become a highly important international body with forty-nine member countries, and a central office in London, and bids fair to realize Mr. Dunlop's vision of a meeting place between scientists and engineers on the one hand and statesmen and economists on the other. The success attained is in no small measure due to his personality and organizing gifts.

The McCharles Prize

The fifth award of the McCharles Prize has recently been made to Harold W. Price, B.A.Sc., professor of electrical engineering in the University of Toronto.

The McCharles Prize was established by the Board of Governors of the University of Toronto through a bequest by the late Æneas McCharles, and provides for an occasional award of the value of $1,000. The award is made for distinction in scientific research, the discovery or invention of processes of benefit to Canada and applicable on a practical scale.

The present award is for the invention and application of devices for improving the control and quality of electric power service in large systems. Its application to the Hydro-Electric Power Commission of Ontario has already produced a marked benefit to electric power users.

RECENT ADDITIONS TO THE LIBRARY

Reports, etc.

Canada, Civil Service Commission: 26th Annual report for the year 1934.

Canadian Electrical Association: Advance Reports for 45th Annual Convention, 1935.

Harbour Commissioners of Montreal: Annual report, 1934.

Canada, National Parks: Annual report of the Commissioner, 1934.

Kenya and Uganda Railways and Harbours: Report of the General Manager, 1934.

Canada, Department of Agriculture: Soil Drifting Control in the Prairie Provinces.

University of Toronto, Faculty of Applied Science and Engineering: Calendar 1935-36.

Canada, Department of Pensions and National Health: Wells, by G. H. Ferguson, and Sewage treatment for isolated Houses and Small Institutions, by G. H. Ferguson.

Ontario, Department of Mines: 43rd Annual Report, Part III, 1934.

American Society of Civil Engineers: Recommendations for Determining Fees to be allowed for Professional Engineering Services and Salaries of Civil Engineers.

Canada, Department of Mines, Mines Branch: Petroleum Fuels in Canada, Deliveries for consumption, 1933.

Canada, Dept. of Mines, Explosives Division: Annual report for 1934.

Technical Books, etc., Received

British Engineers Association: Classified Handbook of members and their manufactures, 1935.

Six Ways to Figure Radiation, edited by Harold L. Alt (*Domestic Engineering Publications*).

Jones' Estimating Tables on Air Requirements and Duct Sizes for Heating and Air Conditioning (*Domestic Engineering Publications*).

The Principles of Electric Power Transmission, by H. Waddicor (*John Wiley and Sons, Inc.*)

BOOK REVIEWS

Six Ways to Figure Radiation

Edited by Harold L. Alt. Published by Domestic Engineering Publications, Chicago. 1935. $2.00. 3¾ by 6½ inches. Imitation leather.

In this small book the author describes six recognized methods of figuring the radiator surface for a house and explains how to use them. Their application is illustrated by a practical example.

Jones' Estimating Tables

By Ernest F. Jones. Published by Domestic Engineering Publications, Chicago. 1935. $2.00. 5¾ by 8¾ inches. 68 pages. Imitation leather.

This book is of interest to those who have to estimate for forced air heating for residences and other small buildings. Four sets of tables (degree difference of 90, 80, 70 and 60) are given with multiplying factors for c.f.m. requirements on nine different factors of heat loss.

The book also contains charts of duct sizes and tables for determining register and riser sizes. An example shows the application of the tables and factors.

The Maiden Voyage of the S.S. "Normandie"

The s.s. *Normandie* of the Compagnie Générale Transatlantique, has secured for France the coveted Blue Riband of the Atlantic on her maiden voyage. The vessel left Le Havre at 5.20 p.m. g.m.t. on Wednesday, May 29th, and proceeded at between 28 knots and 30 knots to Spithead, picking up passengers from England in Cowes Roads. Leaving there in the early hours of Thursday, May 30th, she proceeded down Channel, being at first somewhat delayed by mist. She, however, passed Bishop's Rock, off the Scilly Isles, at 11.48 a.m. g.m.t., and passed the Ambrose Light at 2.50 p.m. g.m.t. on Monday, June 3rd, having thus steamed the intervening distance of 2,971 miles in four days three hours and two minutes, at an average speed of 29.98 knots. Notable as this performance is, it would have been improved upon but for the fact that the speed had to be reduced for a period of about eleven hours on Saturday, June 1st, owing, we understand, to the failure of a condenser tube. It may be of interest to recall here that the Blue Riband was previously held by the *Rex*, with an average speed for the voyage between Gibraltar and New York of 28.92 knots. Before that the *Bremen* made a run between Cherbourg and New York at 28.51 knots, and the *Mauretania*'s record was 27.22 knots between Ambrose Light and Plymouth. The *Mauretania*, it may be remembered, was twenty-two years old when her record was made.—*Engineering.*

Archaouloff System of Fuel Injection in Diesel Engines

The M/S *Calgarolite*, a vessel of 17,000 tons deadweight owned and operated by Imperial Oil, Limited, Toronto, Canada, has recently had the fuel injection system of her main engines converted from air injection to solid injection.

The *Calgarolite* is equipped with twin Krupp six-cylinder, two-stroke cycle single acting diesel engines, each developing 2,450 b.h.p. at 90 r.p.m. Commissioned in July 1929 the vessel's engines were operated under the air injection system till January 1934 when the Archaouloff system of solid injection was installed. This system of fuel injection is easily fitted and does not necessitate any considerable amount of alteration to the engines. The basic idea of the scheme devised by Professor Vadim Archaouloff and further developed by Krupp engineers consists in utilizing the compression pressure in the engine cylinder to operate the airless fuel-injection pump. Briefly, all that is required to convert from air injection to solid injection is to fit in place the Archaouloff injection pump, replace existing fuel valves by different type valves and make a few piping alterations, all of which can be and have been done by the ship's personnel at sea with negligible interruption to the vessel's regular schedule.

Each engine cylinder has its individual injection pump (Fig. 1) which consists of a vertical water cooled cylinder having a bottom but no cover or head and fitted with a piston. This gas or power cylinder is open to the atmosphere at its upper end and at its lower end is connected to the compression space of its respective engine cylinder by means of a pipe. Connected by suitable means to the piston of this cylinder is a second piston or plunger extending upward and working in a fuel cylinder. The fuel cylinder is open to the atmosphere at the lower end and closed by means of a removable head at its upper end. A horizontal duct through the cylinder wall together with a high pressure pipe forms the connection between the fuel space of the fuel cylinder and the fuel injection valve of its respective main engine cylinder. The head of the fuel cylinder is fitted with a spring loaded fuel inlet valve and an escape valve, the latter used for priming purposes when starting up.

The diameter of the gas cylinder is 86 mm. and of the fuel cylinder 25 mm. stroke of each 38 mm. The gas piston is fitted with rings in the usual marine manner while the fuel plunger is of the solid lap fitted type.

The Archaouloff apparatus, gas and fuel components is a compact unit and to install it on the *Calgarolite* all that was necessary was to remove a "U" bend which formerly led the cooling water from the main engine cylinder jacket to the main engine cylinder head, fit a special

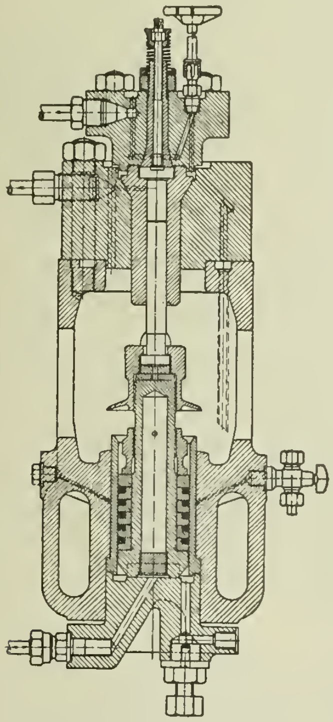

Fig. 1—Section through the Injection Pump—Archaouloff-Krupp Diesel Engine.

elbow to the jacket cooling water outlet in place of the "U" bend, connect the apparatus to this elbow and make a return water pipe from the Archaouloff gas cylinder to the main engine cylinder head. By this means the cooling of the gas cylinder was taken care of and a convenient method afforded of securing the whole apparatus in place without affecting the circulation of the cooling water of the main engines. In addition to above there were necessary alterations to existing fuel piping and the provision of some extra piping and fittings.

Figure 1 shows diagrammatically the Krupp arrangement of the Archaouloff device. *A* is the air cylinder of the injection pump; *B* the fuel-injection pump; *C* the fuel valve; *D* the pipe taking the gas from the combustion chamber to the injection pump which may be shut off by means of cock *E*. The fuel passes at *F* from the fuel pump into the injection pump and into the pressure chamber through valve *G*, then through the pressure pipe *H* to the fuel valve. *J* is a lever connected with the fuel valve in order to vary the tension in the valve spring.

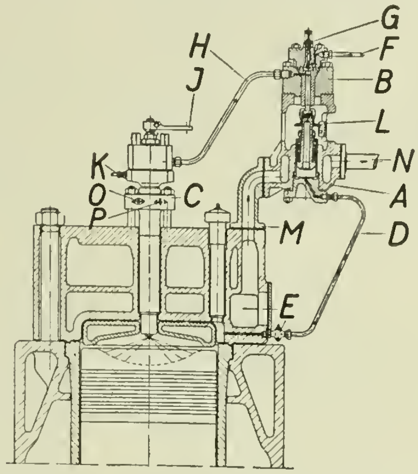

Fig. 2—Section through the Cylinder Head.

K is the connection for a leakage pipe, which provides an outflow for the fuel, which runs in droplets along the valve needle. *L* is a scale showing the lift of the piston.

The cooling water from the cylinder cover used to cool the air cylinder of the injection pump comes in at *M* and leaves at *N*. *O* and *P* are the corresponding cooling-water connections for the fuel valve.

The fuel pumps used on the main engines using air injection system remain unaltered but instead of delivering fuel direct to an air injection cam-operated fuel valve on the main engine cylinder head they now deliver the quantity of fuel necessary for the desired speed of the engine through the spring loaded valve in the fuel cylinder head, the piston being at this time free to move downward to accommodate the amount of fuel delivered. The fuel having been thus delivered compression in the main engine cylinder commences and the under side of the gas piston being in communication with the main engine cylinder by means of a pipe as previously mentioned, a pressure is exerted on this piston, transmitted by it to the fuel plunger and thus to the fuel oil previously delivered to the top of the plunger. The diameter ratio of the gas piston to the fuel plunger being approximately 3.4 to 1 a point is reached at which the pressure on the fuel is sufficiently high to open the automatic fuel injection valve on the main engine cylinder head and the process of injection commences. This process terminates when the fuel plunger closes the horizontal delivery duct in its cylinder wall. The main engine fuel pumps at the proper time again deliver the required quantity of fuel to the fuel cylinder ready for the next revolution, driving the fuel plunger and gas piston downward, a distance according to the amount of fuel delivered.

The Archaouloff system of fuel injection differs from usual methods in both air and solid injection engines in that the timing of injection is not controlled by a cam-actuated fuel injection valve as in an air injection system or by a fuel pump driven by a cam as in other solid injection systems. The timing of injection is controlled by the pressure on the fuel in the fuel cylinder and is not governed by a predetermined crank angle. Injection commences as soon as the pressure on the fuel is sufficient to lift the needle of the spring loaded fuel injection valve on the main engine cylinder head so that beginning of injection is variable with the load of the spring. As combustion commences the pressure on the gas piston increases and the process of injection is accelerated.

The Archaouloff apparatus is purely an injection pump. The amount of fuel delivered to the various cylinders of the engine is controlled by the supply pump, in this case the fuel pumps used in the former air injection system.

Provision is made against overcharge of fuel delivery, for thorough priming previous to starting up and for cutting out any one injection pump for overhaul or repair without stopping the engines.

The system has operated very satisfactorily on the M/S *Calgarolite*. Compared with the former air injection system manoeuvring qualities have been greatly improved, engines start promptly from cold and the quantity of starting air required has been greatly reduced. Since installation of the system the vessel has covered 60,479 nautical miles at an average speed of 12 knots with a fuel consumption of 146.6 bbls. per day. With air injection system for 58,883 nautical miles distance covered the average speed was 12 knots and fuel consumption 159.25 bbls. per day. The reduction of fuel consumption with the solid injection system is 7.94 per cent and further improvement is expected as the period of operation shown includes time spent in making adjustments necessary to obtain efficient operation of the system. Some trouble was at first experienced with leakage in inlet valves on fuel cylinder heads and rings in gas cylinder pistons but these difficulties are being overcome. No trouble is experienced in timing the fuel injection. Adjustment of the fuel injection valve spring can be made easily and accurately and the pressure at which the fuel valve opens is approximately 300 atmospheres.

In September 1934 Imperial Oil, Limited completed installation of the Archaouloff system in their M/S *Victolite*, a twin screw vessel of 16,500 tons d.w., with four cylinder engines of type similar to the *Calgarolite* and the system has now been installed on the M/S *C.O. Stillman* owned by International Petroleum Company, Limited. This vessel is of 24,000 d.w. tons and is engined by twin, six-cylinder, two-stroke cycle, single acting M.A.N. Diesel engines developing a total of 4,300 b.h.p. at 90 r.p.m.

NOTE:—The two illustrations are reproduced from the January, 1935 issue of *Mechanical Engineering*.

Share the Wealth

Abstract of an address given on April 28th, 1935, by W. Cameron of the Ford Motor Company, Detroit.

"Share the wealth" plans usually begin with the assumption that wealth is money. Just share the money and you have shared the wealth! That is a fallacy. Money, being merely part of the bookkeeping system of society, is, or ought to be, the sign of wealth, but it is not and never can be wealth itself.

It is further assumed that wealth can be "shared" by taking it away and giving it away. There is a "catch" here also, for wealth is never wealth in the taking but in the using and the making, and to think of "sharing" as taking is only a half truth. Practically all of the actual wealth under Ford management consists in productive plants and machinery and what goes with them. They are wealth because under proper management they produce what people can use in living or in getting a living. How that machinery could be confiscated, and bit by bit distributed, and still be wealth;—or, if not distributed, how it could be managed by politicians or any other group of theorists and still remain a source of national wealth, no one takes the trouble to explain.

Up to the present time the most effective mechanism that experience has devised to "share the wealth" is industry. Industry is a market where people bring what they have, to get what they need. It is a trading centre where materials, labour, skill and science are changed into commodities useful to life. The farmer brings his produce to get industrial products in return. The miner brings his ore; the weaver his textiles, the millman his steel; the workers in rubber, oil and glass bring their products; railroad men and sailors bring their services and so on through a hundred lines of work that focus in every great industry. Everyone shares in the making in order to share in the taking. He brings goods or work, which is real wealth; he receives dollars which give him a claim on the equivalent of the wealth he has contributed. How this natural process works may be illustrated by what occurred in the Ford Motor Company during the first three months of this year.

The cars we made during those three months consumed more than $48,000,000's worth of labour in our own shops. That labour was rendered in all parts of the country, its equivalent was returned to all parts of the country: more than $3,000,000 in wages for the south, almost $4,000,000 in wages for the west, more than $5,500,000 in wages for the east, nearly $35,000,000 in wages for the great central area of the country. That was for three months in Ford shops only. Now, outside our shops, we bought from other industries more than $214,000,000 worth of materials during those three months. Of this sum those industries paid their employees nearly $72,000,000 in wages, and passed the remaining $142,000,000 along to their suppliers, who in turn paid their employees, and so on back along the whole line of supply until it paid wages to the last producer. So that for those first three months of this year we can count first-hand wage payments of $120,000,000 on work directly done for the Ford industry alone. And we can count an additional $142,000,000 in second-, third- and fourth-hand wage payments for work done for the suppliers of our suppliers all down the line. That is "sharing the wealth." For every car we made, some railroad or other shipping employee received $22 in wages. For every car we made, some worker in a rubber factory received $12.50 in wages. For every car we made, some worker in a steel mill received $12 in wages. And these were repeated 386,326 times over, for that is the number of cars we made during that period. For every ton of coal we burned, some miner received a dollar in wages, and you can multiply that by 600,000 tons. That is sharing. That is not speech-making.

All this in just one industry. Imagine hundreds of industries doing the same thing each in its proportion. Industry can really "share the wealth" because its first concern is to create the wealth. There is no division without creation. Never have creating and sharing been so effectively combined as in industry. There is no other way. The sharing process needs constant improvement, but certainly it does not need introduction. It is already here, and operating.

National Distribution of Electricity, Water and Gas

The striking contrast which existed some time ago between the economists who insisted that individuals should help their country by saving, and the school who considered salvation possible only through spending, was no less notable than that which to-day exists between the advocates and otherwise of public works. It will be remembered that the chief plank of Mr. Lloyd George's last election platform was the expenditure of some £50,000,000 on new roads, at a time when very many thought spending in this direction had already gone further than the actual needs of the country warranted. In this country, the attempt to meet the unemployment difficulty by such means has been spread over many years. Roads have been improved and marine parades constructed at seaside resorts by means of government grants and so on. However, this phase is passed, and there is no doubt that there is quite a body of opinion behind Mr. Runciman and Mr. N. Chamberlain in their contention that further effort in this direction is undesirable at present.

It would be possible, we suppose, to take an example, to compare the effectiveness of the road building schemes of recent years, with that of the grid, as a solution of the unemployment difficulty. The statistics might not be easy to come by, but it would appear to be not at all unlikely that from the employment viewpoint, the country has on the whole spent its money more wisely on the latter than on the former. Both have, of course, involved ancillary industrial activities, but the grid has kept busy many large works all over the country, has kept alive our best designing and business brains, and has employed skilled labour in construction, to say nothing of the industries again behind the makers of plant, added to which, with their works well occupied, many manufacturers have secured contracts which otherwise could not have fallen to them. And, withal, the work has been financed in the ordinary market, with the anticipation of a direct return, whereas road building involves the burden of taxation.

But if electricity is desirable, there is no doubt that water is an essential wherever there are habitations. We can exist without the former, but in the absence of the latter life is impossible. Modern education and sanitary reform have all been in the direction of impressing upon our people, from childhood upwards, the connection between cleanliness and health, and it is manifestly absurd to spend much money in instilling into young minds ideas of life which outside school premises it is impossible to follow. As years have passed, the scale of thought has advanced. A town dweller to-day, always a larger consumer than the countryman drawing from a well, uses far more water than did his father or grandfather. The villager, however, is little better off than formerly.

Any national scheme would, of course, aim at a better use of our resources and a better service to the rural and other areas now ill-supplied. To effect this would mean the opening up of new, and the improved distribution of existing, supplies. While this might mean quite probably relatively long-distance transmission in some cases, it appears to us to be quite beside the point to picture at this stage a very elaborate grid on the lines of the electrical system, merely to prove it to be impossible. Anything in the way of a water grid is clearly to be introduced only where necessary, and after due study and consideration.

As with water and electricity, so with gas. In recent years this industry has had a very well-founded complaint that the weight of the Government has been thrown into the scale in favour of a rival. The two supplies each have their appropriate field, and in some countries, where both are often in the hands of one company, are worked side by side with excellent effect.

At present, the tendency is to absorb companies into larger concerns, to inter-connect between the various works and to work for more efficient production by the use of the best installations of the group. Is it not possible that, taken in hand in the correct way, these might be further welded into a national system of distribution, while retaining, as with electricity, the identity of the actual producers, and, as with electricity, bring to the subject such government backing as would make feasible very great developments of supply. It has even been with some reason suggested that, put upon a similar footing in this respect, the two, electricity and gas, might cease to quarrel and turn their combined weapons on imported fuel.—*Engineering.*

The Canadian Ohio Brass Company Ltd., Niagara Falls, Ont., announces that it has extended the economy of its Universal strain clamp still further by introducing a baby universal clamp. In principle of design this new strain clamp is exactly like the larger O-B universal. The primary snub, in combination with a modified "V" wire-groove and a positive clamping member, makes this smaller clamp applicable to the range of conductor sizes and types used on rural electrification. The only differences in the two universal strain clamps are size and cost. The baby universal will take No. 6 to No. 2 solid or stranded cables.

Sawyer-Massey, Limited, of Hamilton, Ontario, have recently issued an attractive catalogue descriptive of their manufacturing facilities and illustrating the wide variety of equipment produced by the General Contract Department of their Industrial Division at their plant in Hamilton.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situation Vacant

PLANT ENGINEER, required for a modern newsprint mill in the province of Ontario. Give age, experience, education and salary expected. Reply to Box No. 1170-V.

Situations Wanted

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

CONSTRUCTION ENGINEER, age 26, unmarreid, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

Situations Wanted

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box. No. 651-W.

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

An Interesting Experiment

Particulars of an interesting venture in endeavouring to assist junior engineers to secure employment in the mining district have been received from Manitoba.

During the past two or three years, the Joint Committee on Unemployment of The Institute and the Association of Professional Engineers made every possible effort to keep in touch with the mines in the province of Manitoba in the hope that young engineers might secure employment as labourers, and thus be on the ground when openings for engineering services should occur. Time after time, the Committee was too late in getting into touch with the mining officials. By the time a letter recommending a man for a job reached the mine, the position had been filled by someone on the site. Consequently the Joint Committee sponsored the idea of a camp to be established in the Rice Lake district, and four men were selected from the unemployed junior engineers to proceed to the central mines area and erect the shack. The cost was met by a grant from the Association of Professional Engineers of the Province of Manitoba to the Joint Committee, and transportation and living expenses were advanced to the four engineers selected, with the understanding that refunds should be made by them in instalments if and when they secured employment.

It is part of the plan that should permanent employment be obtained by the engineers in the camp, other unemployed engineers will be sent up. Provisions will thus be provided for four unemployed men at the camp during the entire summer. The camp was opened in April of this year and it is hoped that several men will be placed as the busy season in the mines opens up.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q, married. Desires position, preferably with construction firm Experience includes railway, monument and mil building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

Situations Wanted

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.SC. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.SC. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

Situations Wanted

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.SC. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.SC. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.SC. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.SC., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.SC. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W.

Situations Wanted

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.SC., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.SC., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.SC. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

COMBUSTION ENGINEER, A.M.E.I.C., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

CIVIL ENGINEER, B.SC. '29, JR.E.I.C., age 29, single. Experience in all types of surveying including use of aerial photographs. Three years on hydro-electric power development in field and office. Instrumentman on concrete road construction. Location immaterial. Apply to Box No. 1254-W.

ELECTRICAL ENGINEER, B.SC. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '29). Age 28. Six years experience in automobile office and plant; two years as supervisor of inspection in body assembly. Good understanding of modern business methods applied to manufacturing. Desires position with production department of smaller Ontario industry. Good references. Interviews anywhere in central Ontario. Apply to Box No. 1270-W.

ELECTRICAL GRADUATE, S.E.I.C., B.SC. '32, M.SC. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.SC., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public"

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Design of Continuous Reinforced Concrete Arches by the Fixed Point Method
For the Cathedral, at Valleyfield, Que.

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Part I*

SUMMARY.—This paper explains the general theory of the fixed point method and gives in detail an actual application of the method for the design of the reinforced concrete arches of the Cathedral at Valleyfield, Que.

On September 22nd, 1933, a fire destroyed the St. Cecile Cathedral at Valleyfield. As the structure had to be considered a total loss and as the loss was satisfactorily covered by insurance, the owners, "La Corporation Episcopale C. R. de Valleyfield," decided to rebuild the Cathedral entirely and to adopt a type of construction which would be as fireproof as possible.

This article is intended to illustrate the application of what is known as the "fixed point method" in the statical analysis of a continuous reinforced concrete frame which is statically indeterminate in the sixth degree. Although the above-mentioned method of computing continuous elastic frames is not new and is rather commonly used by the European designing engineer, it is amazing how little has been written on this subject in Canadian or American engineering periodicals. With the exception of Hardy Cross's paper and the subsequent discussions which appeared in the proceedings of the American Society of Civil Engineers, little has been published which would give the student in structural engineering a method of statical analysis which would eliminate, at least to some extent, the need of applying the principle of least work, the theory of elasticity or Mohrs' principle of elastic deformations. It is, therefore, understandable why the average engineer shuns calculating anything but the most elementary elastic deformation by the above methods unless he is a wizard in higher mathematics. It is the writer's hope, therefore, that this article will prove to be of interest from a designer's point of view and will start a discussion which is always valuable to the student who specializes in this particular line of engineering.

As already pointed out above, the chief object of the design was primarily to achieve structural economy. This object was obtained by the selection of the materials of the structure best adapted to the specific requirements and by saving no efforts in analyzing the various highly statically indeterminate frames in order to secure maximum efficiency of the materials chosen. In other words, no hinges were assumed or inserted to simplify the calculations, unless an actual saving in construction cost was the result.

The choice of materials to be used was rather limited, on account of the fact that an absolutely fireproof construction was specified. The following types of construction were, therefore, considered:—

(*a*) Structural steel fireproofed with concrete and gunite.
(*b*) Reinforced concrete.

*Part II to appear in September issue of The Journal.

The preliminary cost analysis revealed the fact that structural steel would necessitate a larger space in the roof section than the architect was ready to allow for the supporting structure. Even if the architect would have been ready to make such a concession as to raise the roof to a higher level, the additional cost of the outside walls together with the extra cost of the suspended vaulting would make this type of construction economically impossible.

It was, therefore, decided to execute the structure of the cathedral in reinforced concrete.

In order to eliminate a lengthy description of the layout of the church, the general plan of the ground floor as well as a typical cross-section are shown in the accompanying figure which is self-explanatory.

The standard frame, the general dimensions of which are shown in Fig. 15 and the detailed stress analysis of which is given in this article, was adopted after a comparison of various rigid frames. Two of these alternative frames are shown in Figs. 1a to 1b which were analyzed to obtain the most economical solution.

Such a preliminary study can best be made by using the formulae of Professor Dr. Ing. A. Kleinlogel, which he published in his book "Mehrstielige Rahmen." With the help of these formulae, it was possible to obtain first of all in a very short time the preliminary dimensions of the different members of the frame, and it enables also the designer to obtain a fairly good picture of the economical advantages of one frame over another.

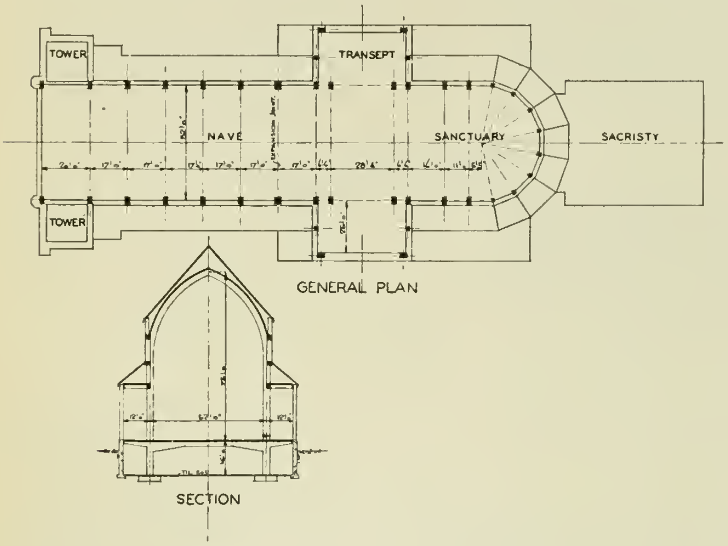
The type of frame as shown in Fig. 1b was found to be superior as far as the cost of the construction is concerned. In addition to this, the depth of the centre beam on the ground floor slab could be reduced considerably, thus meeting with the wishes of the architect, as the head room for the community hall in the basement was rather restricted.

Other advantages were derived by the elimination of the outside wall columns, such as:—

(*a*) The ground floor brackets supported on the inner column and reaching to the outside wall tend to reduce the large negative bending moment at the head of the basement column and also help to reduce the positive bending moment of the centre beam.

(*b*) In case of an uneven settlement of the footings supporting the two main columns, the extra moments due to such settlements are reduced to a very great extent, due to the fact that all exterior walls are independent of the frame and can move in a perpendicular direction without producing any additional stresses in the frame. The joint between walls and brackets are so arranged that only horizontal forces such as wind loads will be transmitted upon the frame.

The final stress analysis of the rigid frame which was found to be the most economical was made according to the fixed point method originally developed by Professor Dr. Wilhelm Ritter, and which was presented in a more useful



Schematic Sketch of Church Framing.

form for the practising engineer by Dr. Ing. Ernst Suter, who extended the method, so that the principle can also be applied to continuous arches as well. (See "Methode der Festpunkte" by Dr. Ing. Ernst Suter.) The method enables the designer to analyze in a clear and simple way any statically indeterminate structure composed of arches, beams and columns joined monolithically together at any angle. Among the many advantages of this method over an analytical stress analysis, are the following:—

(*a*) All complicated formulae are eliminated.

(*b*) The procedure of the analysis can be followed graphically and the calculations can easily be checked at any time during the analysis. It is, therefore, not necessary to complete the entire analysis before a check can be made of the result.

(*c*) The fixed point method is shorter than any analytical method when highly statically indeterminate structures with variable moments of inertia, have to be analyzed, especially if a great number of various loads have to be considered, in order to obtain the possible maximum stresses at any point of the frame.

Although it would be quite possible with the help of the theory of virtual displacements, method of least work, or the general theory of elasticity, to write down the six equations necessary for every type of loading applied to the frame in question, the time required to do all this mathematical work would be impossible, economically and practically, as slide rule calculations would not be accurate enough.

The fixed point method also makes available without much extra work certain information about a given frame such as:—

1. The extent to which the moments are affected due to a partial or total restraining effect of the ground floor slab to prevent the horizontal displacement of the joints, or what is known as side-sway.

2. The extent to which the moments are affected due to an assumed uneven settlement of the foundation of the frame.

The theory of fixed points.

The method is based generally on Mohr's principle, namely, that the angular deformations of elastic lines at supports are equal to the reactions of the member, loaded by its moment area divided by the product of the moment of inertia times the coefficient of elasticity of the material of which the member consists.

The analysis is divided into two stages.

Stage I deals with the determination of the moments and shear diagrams, under the assumption that the joints of the frame cannot sway-sideways, in other words, temporary imaginary supporting forces are applied at any joint which would ordinarily move sideways. These imaginary supports are called by Suter "holding forces." (See Fig. 2a to 2c.)

Stage II deals with the determination of the moments and shears due to the removal of the holding forces. These moments and shears can easily be obtained by loading the frame with each of the holding forces in the opposite direction in which they act as supports. (See Fig. 2b.) The magnitude of the holding forces is already known from the analysis of the frame in Stage I.

When both calculations under Stage I and Stage II are finished, the results are superimposed to obtain the final result of moments and shears. (See Fig. 2.)

To obtain the moments for both Stages I and II, the location of the fixed points have to be determined first. But before going any further, an explanation seems to be in order as to what exactly the so-called fixed point is, and what can be done with it.

Fixed point is called the zero moment point, when the end of a restrained beam (assumed to be without dead weight) is caused to rotate to a certain angle. (See Fig. 3.)

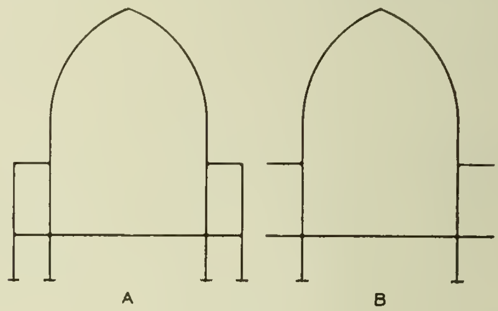


Fig. 1.

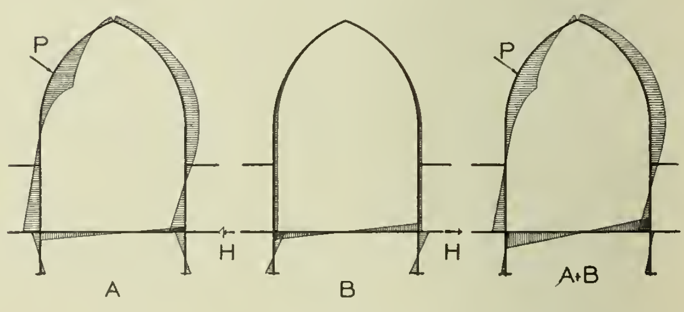


Fig. 2.

Thus, if the right end of the beam is angularly turned, we determine the left fixed point, and if we turn the left end of the beam, the right fixed point is obtained. The moment line is, in both cases, a straight line, and intersects the axis of the beam at the fixed point.

There are always two fixed points to each member of a frame, provided both ends are restrained by adjacent members, or by the characteristics of the support. If one end of a member has a hinged support, the fixed point is located at the support itself, the distance from support to fixed point becomes, therefore, zero.

The formula for the distance of the fixed points from the support of the member of the frame takes the following into consideration:—

(*a*) The elastic deformation of the member itself due to the rotating moment applied at the support. In this case, the modulus of elasticity of the material of the frame is assumed to be uniform.

(*b*) The elastic deformation of the support opposite the end where the rotating moment is applied.

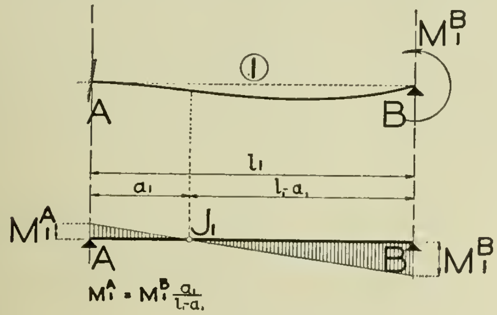


Fig. 3.

It can be seen from the above therefore that the location of the fixed points is solely dependent on the relative stiffness of the member under consideration and the proportional stiffness of the support, or adjacent members of the frame. This is one of the main characteristics of the fixed point, that no matter to what kind of a load each member is subjected, the locations of the fixed points are not changed at all, hence the name fixed point.

In order to illustrate the simplicity of the method in general, the procedure is shown in the following example and explained step by step.

1. Determine location of fixed points.
2. Determine the negative moments of the loaded span. $M_4{}^D$ and $M_4{}^E$ solved by simple graphical method.
3. Plot line from support E through fixed point K_5.

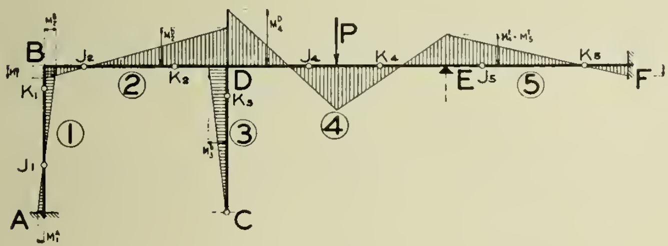


Fig. 4.

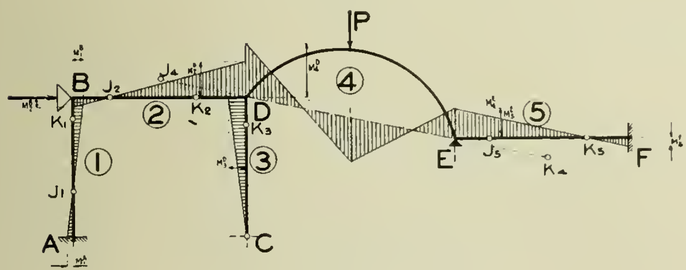


Fig. 5.

4. Split moments $M_4{}^D$ into moments $M_2{}^D$ and $M_3{}^D$ (use carry-over coefficients), draw a line from D with $M_2{}^D$ as ordinate through J_2, and continue from B, with $M_2{}^B$ as moment through J_1 to A.
   Draw a line starting at D, with $M_3{}^D$ as moment at the head of column 3 to the foot C of column 3.
5. With all the moments known, the shear diagram and all reactions at points A, C, E and F can be determined with the ordinary laws of statics.

To obtain the few values mentioned in steps 1 to 4, such as the location of the fixed points, the end moments at the supports D and E of the loaded span and the carry-over coefficients with which $M_4{}^D$ has to be multiplied to obtain $M_2{}^D$ and $M_3{}^D$, ready made formulæ can be applied which have been worked out by Ritter, Strassner and Suter. The application of these formulæ will be shown in detail later when discussing the actual analysis of the church frame.

In case one member of the frame shown in Fig. 4 has not a straight axis, the procedure would be exactly the same as before, except that the final moment of the arch would have to be corrected, by deducting the value of the product of the horizontal thrust multiplied by the height of the arch axis above the base line of arch (See Fig. 5.)

A temporary holding force would have to be assumed at point B or D (it is immaterial which), to prevent the joints B and D from swaying sideways. The extra moments

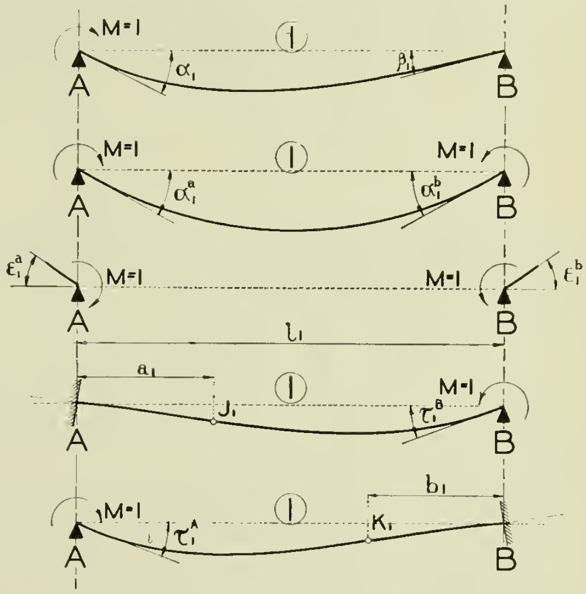


Fig. 6.

due to the release of point B would then have to be determined in the manner as explained previously. (Stage II.)

The following calculations give a detailed analysis of the standard frame of the Valleyfield Cathedral. Most of the calculations are illustrated, so as to make it easy to follow the application of the method adopted.

Determination of fixed points.

The general formula for the distance a and b of the fixed points J and K respectively is as follows:—

$$a_1 = \frac{l_1 \times \beta_1}{\alpha_1{}^a + \epsilon_1{}^a} \qquad b_1 = \frac{l_1 \times \beta_1}{\alpha_1{}^b + \epsilon_1{}^b}$$

for notations used see Fig. 6.

l_1 = length of span in feet of member 1.

β_1 = angular deformation of member 1 at support B, due to an external moment $M = 1$ foot-pound applied at support A.
(*Note.* The value of β at the support A, in case $M = 1$ foot-pound is applied at support B, is the same according to Maxwell's theorem of reciprocal displacements.)

$\alpha_1{}^a$ = angular deformation of member 1 at support A due to $M = 1$ foot-pound applied at both supports.
(*Note.* $\alpha_1{}^b$ has not the same value as $\alpha_1{}^a$ if the moment of inertia of the member is not uniform throughout.)

ϵ_1^a = angular deformation of the elastic support A due to a unit moment $M = 1$ foot-pound applied at the support A.

The latter angle varies between zero, in case of full restraint, and infinity in case of no restraint. In the first case, the distance a_1 becomes 1/3 of the span if the moment of inertia of the member is uniform and in the second case a_1 = zero.

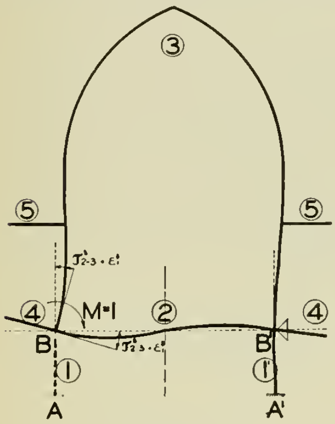


Fig. 7.

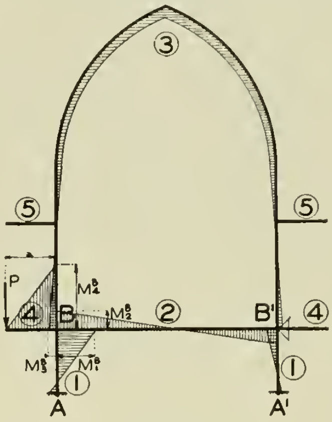


Fig. 8.

The value ϵ^a at joint B of member 1 is equal to the combined angular deformation of the members 2 and 3 due to a moment $M = 1$ foot-pound applied at B. (See Fig. 7.) This angle is expressed thus:

$$\epsilon_1^B = \tau^B{}_{2-3} = \frac{1}{\frac{1}{\tau_2^B} + \frac{1}{\tau_3^B}}$$

In this case, member 1 is assumed removed. The angle $\tau^B{}_{2-3}$ is derived as follows:—

The moment M_1^B at the head of the column 1 produces an angular displacement of both ends of the members 2 and 3 at joint B, and consequently the two rotating moments M_2^B and M_3^B. As the original angle between members 1, 2 and 3 remains unchanged, we can write:

(a) $M_1^B \times \tau^B{}_{2-3} = M_2^B \times \tau_2^B$

(b) $M_1^B \times \tau^B{}_{2-3} = M_3^B \times \tau_3^B$

We know also that

(c) $M_1^B = M_2^B + M_3^B$

therefore

(d) $M_2^B = M_1^B \times \frac{\tau^B{}_{2-3}}{\tau_2^B}$

(e) $M_3^B = M_1^B \times \frac{\tau^B{}_{2-3}}{\tau_3^B}$

and by entering the values d and e in equation c we obtain

$$M_1^B = M_1^B \times \frac{\tau^B{}_{2-3}}{\tau_2^B} + M_1^B \times \frac{\tau^B{}_{2-3}}{\tau_3^B}$$

or,
$$M_1^B = M_1^B \times \tau^B{}_{2-3}\left[\frac{1}{\tau_2^B} + \frac{1}{\tau_3^B}\right]$$

by eliminating M_1^B we obtain

$$\tau^B{}_{2-3} = \frac{1}{\frac{1}{\tau_2^B} + \frac{1}{\tau_3^B}} = \epsilon_1^B$$

as indicated above.

In a similar way value ϵ_2^B can be expressed:

$$\epsilon_2^B = \tau^B{}_{1-3} = \frac{1}{\frac{1}{\tau_1^B} + \frac{1}{\tau_3^B}}$$

and
$$\epsilon_3^B = \tau^B{}_{1-2} = \frac{1}{\frac{1}{\tau_1^B} + \frac{1}{\tau_2^B}}$$

With the help of the above indicated angles of deformation τ, the carry over coefficients μ are obtained.

In the case shown in Fig. 8, the bending moment $M_4^B = P \times a$ is divided into the moments M_1^B, M_2^B and M_3^B. These moments are all smaller than M_4^B. The carry-over coefficients μ with which we want to multiply the moment M_4^B to obtain the three moments M_1^B, M_2^B and M_3^B are, therefore, all smaller than 1 and the sum of three must be = 1.

$$M_1^B = M_4^B \times \frac{\tau^B{}_{1-2-3}}{\tau_1^B} = M_4^B \times \mu^B{}_{4-1}$$

(The subscript of μ denotes the carry-over coefficient at joint B with which the moment of the member 4 at B has to be multiplied to obtain the moment of member 1 at joint B.)

$$M_2^B = M_4^B \times \frac{\tau^B{}_{1-2-3}}{\tau_2^B} = M_4^B \times \mu_{4-2}$$

$$M_3^B = M_4^B \times \frac{\tau^B{}_{1-2-3}}{\tau_3^B} = M_4^B \times \mu_{4-3}$$

The values μ are therefore

$$\mu^B{}_{4-1} = \frac{\tau^B{}_{1-2-3}}{\tau_1^B}$$

$$\mu^B{}_{4-2} = \frac{\tau^B{}_{1-2-3}}{\tau_2^B}$$

$$\mu^B{}_{4-3} = \frac{\tau^B{}_{1-2-3}}{\tau_3^B}$$

A moment of member 1 at joint B to be carried over to the members 2 and 3 would have to be multiplied by:

$$M_1^B \times \mu^B{}_{1-2} = M_2^B$$
$$M_1^B \times \mu^B{}_{1-3} = M_3^B$$

in which

$$\mu^B{}_{1-2} = \frac{\tau^B{}_{2-3}}{\tau_2^B}$$

$$\mu^B{}_{1-3} = \frac{\tau^B{}_{2-3}}{\tau_3^B}$$

Thus we obtain in a similar manner for a moment of beam 2 at joint B to be carried over to column 1 and arch 3

$$\mu^B{}_{2-1} = \frac{\tau^B{}_{1-3}}{\tau_1^B}$$

$$\mu^B{}_{2-3} = \frac{\tau^B{}_{1-3}}{\tau_3^B}$$

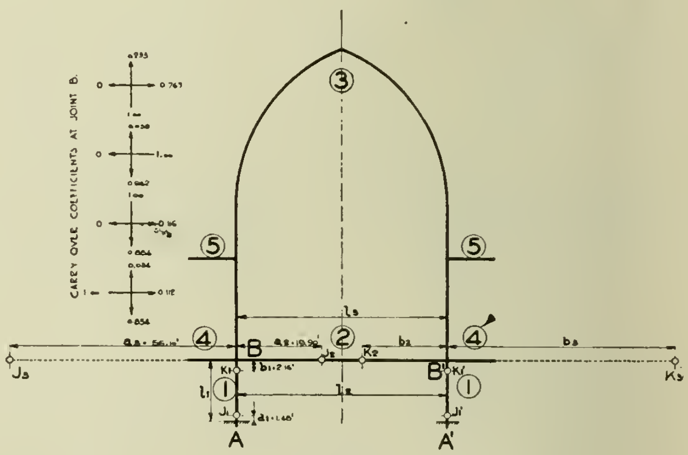


Fig. 9.

and for a moment to be carried over from the arch 3 at joint B to member 1 and 2

$$\mu^B{}_{3-1} = \frac{\tau^B{}_{1-2}}{\tau_1^B}$$

$$\mu^B{}_{3-2} = \frac{\tau^B{}_{1-2}}{\tau_2^B}$$

It can be seen that altogether three angular displacements of each end of every member in the frame have to be determined in order to obtain the location of the fixed points J and K of each member. These angular displacements are α^a or α^b (in case of unsymmetrical members), β and ϵ^a or ϵ^b which latter angle is a combination of the angles τ. As the frame to be analyzed is a so-called closed frame, the procedure to obtain the location of the fixed points is as follows (see Fig. 9):—

Start at the foot of column 1 and obtain a_1 by estimating the degree of restraint the spread footing will exert on the foot of the column. Determine the angle τ_1^B according to formula

$$\tau_1^B = \alpha_1^b - \frac{l_1}{l_1 - a_1} \times \beta_1$$

In order to calculate $a_3 = \dfrac{l_3 \times \beta_3}{\alpha_3^a + \epsilon_3^B}$ of the arch, the value

$$\epsilon_3^B = \tau^B{}_{1-2} = \frac{1}{\dfrac{1}{\tau_1^B} + \dfrac{1}{\tau_2^B}}$$

is needed which in turn requires the angle τ_2^B. But as the formula

$$\tau_2^B = \alpha_2^a - \frac{l_2}{l_2 - b_2} \times \beta_2$$

contains the distance b_2, which is not yet known, it is necessary to assume b_2 temporarily to proceed with the calculations. This assumed distance b_2 is obtained later directly and if the result does not check with the estimated value, the calculation has to be repeated by using the corrected value b_2. A designer familiar with the method usually needs only one correction, in order to obtain the final check of the assumed distance. Finally with τ_2^B known, the angular deformation ϵ_3^B is obtained, which in turn is entered in the equation.

$$a_3 = \frac{l_3 \times \beta_3}{\alpha_3^a + \epsilon_3^B}$$

with a_3 known, the angular displacement $\tau_3^{B'}$ is determined by the equation

$$\tau_3^{B'} = \alpha_3^b - \frac{l_3}{l_3 - a_3} \times \beta_3$$

and as the value τ_1^B is already known which is on account of symmetry equal to $\tau_1^{B'}$ the angular deformation $\epsilon_2^{B'}$ can be determined by the equation

$$\epsilon_2^{B'} = \tau^{B'}{}_{3-1} = \frac{1}{\dfrac{1}{\tau_3^{B'}} + \dfrac{1}{\tau_1^{B'}}}$$

and finally the distance of the fixed point b_2 can be obtained by the formula

$$b_2 = \frac{l_2 \times \beta_2}{\alpha_2^b + \epsilon_2^{B'}}$$

As indicated above, this value b_2 must equal the b_2 temporarily assumed previously. If the two values are the same, the procedure can be continued to obtain b_1 by the formula

$$b_1 = \frac{l_1 \times \beta_1}{\alpha_1^b + \epsilon_1^B}$$

in which $\epsilon_1^B = \tau^B{}_{2-3} = \dfrac{1}{\dfrac{1}{\tau_2^B} + \dfrac{1}{\tau_3^B}}$

All the locations of the fixed points for each member are now known, because, on account of symmetry,

$$a_2 = b_2$$
$$a_3 = b_3$$

The following calculations are now given to illustrate the actual application of the method.

A. *Determination of the angles α and β.*

1. The angles α_1^a, α_1^b and β_1 for column 1 are obtained by the following equations. (See also Fig. 10 for notations.)

$$E\,\alpha_1^a = \frac{1}{l_1} \sum_0^{l_1} wz'$$

$$E\,\alpha_1^b = \frac{1}{l_1} \sum_0^{l_1} wz$$

$$E\,\beta_1 = \frac{1}{l_1^2} \sum_0^{l_1} wzz'$$

of which $w = \dfrac{\Delta s}{I}$ = the elastic weights of the member.

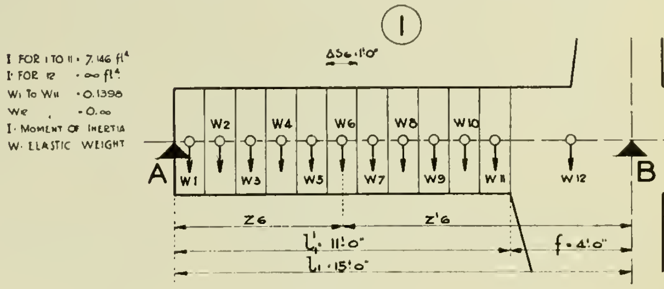


Fig. 10.

The moment of inertia from the footing to the start of the haunch of the beam is constant and amounts to

$$I = \frac{b \times d^3}{12} = \frac{2 \times 3.5^3}{12} = 7.146 \text{ ft.}^4$$

The moment of inertia from beginning of the haunch of the beam to the intersection of axis of members 1 and 2 becomes infinitely large and therefore the elastic weight for this distance is equal to zero.

$$E\,\alpha_1^a = \frac{l_1'}{I} \times \left[\frac{l'}{2} + f\right] \times \frac{1}{l_1} = \frac{l_1'\,[l_1' + 2f]}{2\,l_1\,I_1}$$

$$E\,\alpha_1^b = \frac{l_1'}{I} \times \frac{l_1'}{2} \times \frac{1}{l_1} = \frac{l_1'^2}{2\,I\,l_1}$$

in a similar manner

$$E\,\beta_1 = \frac{l_1'^2 \times [l_1 + 2f]}{6\,l_1^2\,I}$$

therefore

$$E\,\alpha_1^a = \frac{11\,[11 + 2 \times 4]}{2 \times 15 \times 7.146} = 0.974$$

$$E\,\alpha_1^b = \frac{11^2}{2 \times 15 \times 7.146} = 0.564$$

$$E\,\beta_1 = \frac{11^2[15 + 2 \times 4]}{6 \times 15^2 \times 7.146} = 0.288$$

2. *Angular deformations α_2^a, α_2^b and β_2 of beam 2.*

In Fig. 11 are shown all values which are needed to solve the equations for the three angular deformations. The diagram also shows how these angles can be obtained graphically.

The procedure to obtain these angles graphically is as follows:—

1. Divide the span into a number of small sections and determine the moment of inertia for each section.
2. Draw a line representing the moment which is applied at the support to cause the angular deformation, and divide the area of the moment belonging to each section of the span by the moment of inertia of that section.
3. Draw a funicular polygon by using as loads the reduced moment area of each section. The reactions obtained with this polygon represent the angular deformations required.

The following table shows the analytical method of obtaining these angular deformations.

TABLE I

Section	I	Δs	w	z	z'	wz	wzz'
1	13.900	2.125	0.1529	2.8125	49.1875	0.430	21.12
2	10.750	2.125	0.1976	4.9375	47.0625	0.976	45.95
3	8.160	2.125	0.2605	7.0625	44.9375	1.840	82.70
4	6.020	2.125	0.3530	9.1875	42.8125	3.242	138.80
5	4.290	2.125	0.4955	11.3125	40.6875	5.610	228.00
6	2.930	2.125	0.7250	13.4375	38.5625	9.740	375.50
7a	3.635	2.875	0.7905	15.9375	36.0625	12.590	454.00
7b	3.635	2,875	0,7905	18.8125	33.1875	14.870	493.00
7c	3.655	2.875	0.7905	21.6875	30.3125	17.140	520.00
7d	3.635	2.875	0.7905	24.5625	27.4375	19.410	533.00
7d'	3.635	2.875	0.7905	27.4375	24.5625	21.700	533.00
7c'	3.635	2.875	0.7905	30.3125	21.6875	23.980	520.00
7b'	3.635	2.875	0.7905	33.1875	18.8125	26.220	493.00
7a'	3.635	2.875	0.7905	36.0625	15.9375	28.500	454.00
6'	2.930	2.125	0.7250	38.5625	13.4375	27.950	375.50
5'	4.290	2.125	0.4955	40.6875	11.3125	20.150	228.00
4'	6.020	2.125	0.3530	42.8125	9.1875	15.110	138.80
3'	8.160	2.125	0.2605	44.9375	7.0625	11.710	82.70
2'	10.750	2.125	0.1976	47.0625	4.9375	9.300	45.95
1'	13.900	2.125	0.1529	49.1875	2.8125	7.520	21.12
		52.000				277.988	5784.14

$$E\,\alpha_2^a = E\,\alpha_2^b = \frac{277.988}{52} = 5.35$$

$$E\,\beta_2 = \frac{5784.14}{52^2} = 2.14$$

3. *Values of α_3^a, α_3^b and β_3 for Arch 3.*

The formula for the distance a_3 and b_3 of the fixed points for the arch is again

$$a_3 = \frac{l_3 \times \beta_3}{\alpha_3^a + \epsilon_3^a} \quad ; \quad b_3 = \frac{l_3 \times \beta_3}{\alpha_3^b + \epsilon_3^b}$$

The angular deformations at the supports of the two-hinged arch (as shown in Fig. 12) due to a moment $M = 1$ foot-pound applied at the support of the arch have to be determined. But before the formulæ for these angles can be obtained, the horizontal thrust due to the moment

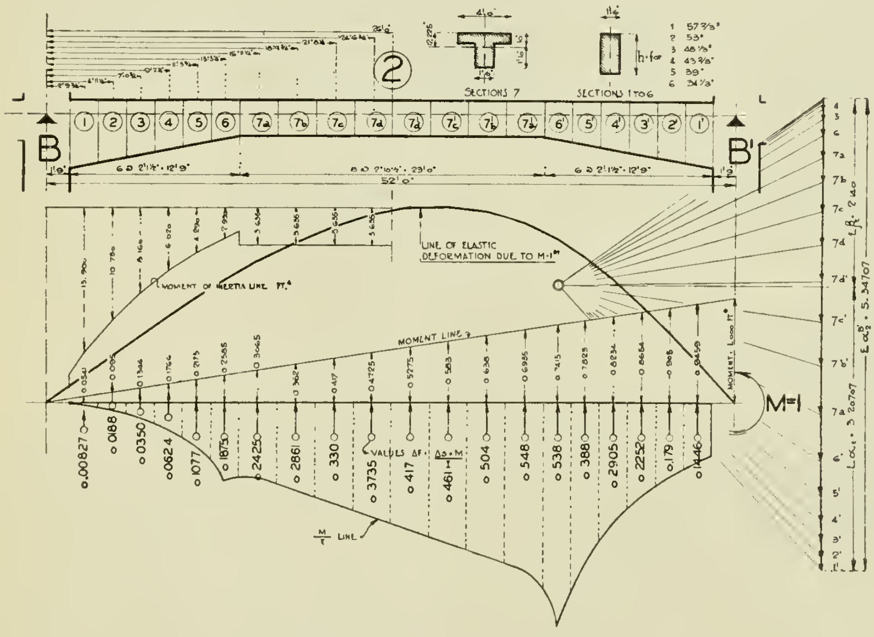


Fig. 11.

causing those angular deformations has to be known. This horizontal thrust can best be determined by means of the principle of least work. According to Müller-Breslau, the general equation based on the theorem of least work is, if the rib shortening due to direct stress and the influence of temperature changes is neglected,

$$L_a = \int \frac{M\,M_a\,ds}{EI}$$

in which

L_a = the virtual work of the reactions at the support for the condition $X_a = 1$ (see also Fig. 13).

M = Bending moment due to the external loads applied on the statically indeterminate frame.

M_a = Moment in statically determinate frame due to $X_a = 1$.

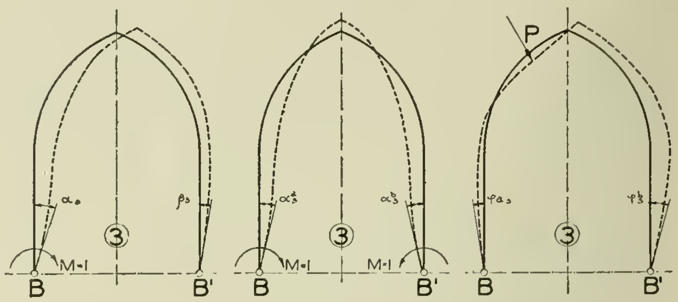


Fig. 12.

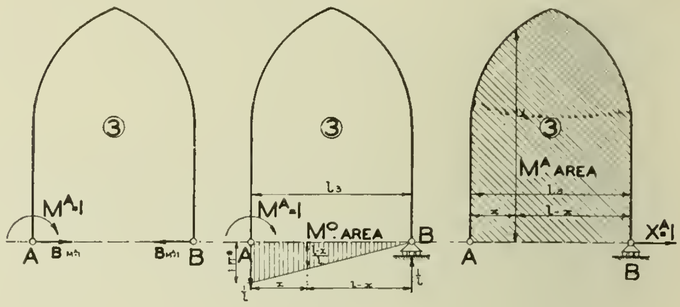


Fig. 13.

As the virtual work L_a must be zero, because the supports cannot move from their original position, the above equation becomes

$$0 = \int \frac{M\,M_a\,ds}{EI}$$

If the value M is now substituted with the value

$$M = M^0 - X_a \times M_a$$

of which M^0 = represents the bending moment of the statically determinate frame, due to the external loading (see Fig. 13), the above equation reads then

$$o = \int \frac{M^0\,M_a\,ds}{EI} - X_a \int \frac{M_a^2\,ds}{EI}$$

or in other words, $\int \frac{M^0\,M_a\,ds}{EI}$ expresses the value of the displacement of the support of the principal frame, or statically determinate system, due to the exterior load applied on the frame, and the value $X_a \int \frac{M_a^2\,ds}{EI}$ represents the displacement of one of the arch supports of the principal system due to the application of the wanted horizontal thrust at the support.

The horizontal thrust is therefore

$$X_a = \frac{\int \frac{M^0\,M_a\,ds}{EI}}{\int \frac{M_a^2\,ds}{EI}}$$

According to this formula, the horizontal thrust due to the application of a bending moment of 1 foot-pound at support A is therefore as follows. (See Fig. 13.)

$$M^0 = \frac{l-x}{l} \qquad M_a = y \qquad \frac{ds}{I} = w$$

$$E\int M^0\, M_a \frac{ds}{I} = \sum_0^l y \frac{l-x}{l} w$$

$$E\int M_a^2 \frac{ds}{I} = \sum_0^l y^2 w$$

therefore

$$X_a = \frac{\sum_0^l y \frac{l-x}{l} w}{\sum_0^l y^2 w} = \frac{1}{l}\, \frac{\sum_0^l y\,[l-x]\,w}{\sum_0^l y^2 w}$$

The notation used by Suter for this thrust is $B_{(M^A=1)}$ of which the subscript denotes that the thrust is due to a moment = 1 foot-pound applied at support A.

The thrust $B_{(M^B=1)}$ due to a moment equal to 1 foot-pound applied at the support B can be derived in a similar manner and amounts to

$$B_{(M^B=1)} = \frac{1}{l}\, \frac{\sum_0^l yxw}{\sum_0^l y^2 w}$$

and the thrust B due to the application of a moment of 1 foot-pound simultaneously at both supports of the two hinged frame amounts to

$$B = \frac{\sum_0^l yw}{\sum_0^l y^2 w}$$

It can be seen that all values B are only dependent on the dimensions and shape of the frame, and are not influenced by the external loads applied on the arch.

The derivation of the formula for the angular deformations α and β, as given by Suter, is rather an intricate application of the theorem of least work. The following derivation of the angular deformation, as shown in Fig. 12, gives a considerably simpler illustration of the application of the principle of least work.

If a rotating moment = 1 foot-pound is applied at the support B, thereby causing an angular deformation β at support B' (see Fig. 12), then the bending moments at any point of the frame amount to

$$M = M^0 - B_{(M^A=1)} \times y \qquad \text{(See Fig. 14)}$$

the angular deformation can therefore be obtained in two easy steps, by computing first the angle β^0 due to M^0 of the statically determinate system, and secondly, by deducting the angle β_B due to the horizontal thrust $B_{(M^A=1)}$, also of the statically determinate system. For each step, the general equation based on the theorem of least work reads in this case

$$\beta^0 = \int \frac{M^a\, M ds}{EI}$$

$$\beta_B = \int \frac{M^a\, M ds}{EI}$$

$$\beta = \beta^0 - \beta_B$$

In the case of β^0 the following values can be placed under the integral.

M^a = Loading group: Applied at that point of the frame where the deformation is wanted. As an angular turn of joint B' is wanted, a rotating moment $\overline{M}$ = 1 foot-pound is applied there and the value M^a becomes therefore

$$M^a = \frac{\overline{M}x}{l} \text{ or } = \frac{x}{l}.$$

M = Displacement group: Influence of the load which actually causes the wanted deformation. It is therefore

$$M = M^0 = \frac{l-x}{l}.$$

These values entered into the above equation, gives

$$\beta^0 = \int \frac{\frac{x}{l} \times \frac{l-x}{l} \times ds}{EI} = \frac{1}{El^2}\int x\,[l-x]\,\frac{ds}{I}$$

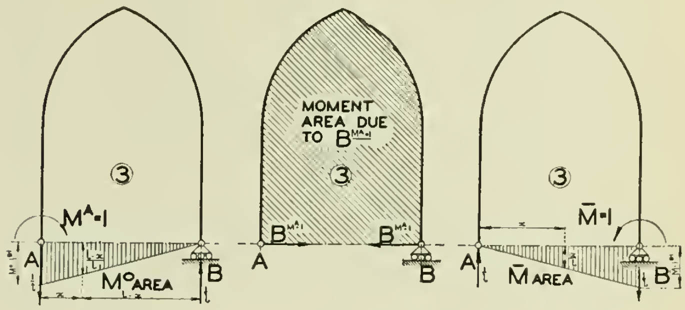


Fig. 14.

As the moment of inertia I in the integral is variable, it is not possible to solve the integral, and it is necessary to subdivide the arch into a number of small sections. At the same time, the values $\frac{ds}{I}$ can be replaced by the elastic weights. The equation reads therefore

$$\beta^0 = \frac{1}{El^2} \sum_0^l x\,[l-x]\,w$$

To obtain β_B the procedure is again as follows:

M^a = Loading group: load $\overline{M}$ = 1 applied at B' where deformation is wanted.

M^a is therefore again $= \frac{\overline{M}}{l}x$ or $\frac{x}{l}$

M = Displacement group: Influence of load actually causing required angular deformation β_B therefore

$$M = B_{(M^A=1)}\, y$$

these values entered in equation for β_B give:

$$\beta_B = \int \frac{\frac{x}{l} \times B_{(M^A=1)}\, y\, ds}{EI} = \frac{1}{El} B_{(M^A=1)} \int \frac{xy\, ds}{I}$$

or again $\qquad \beta_B = \frac{1}{El} B_{(M^A=1)} \sum_0^l xyw$

and finally if the two values are entered in the equation

$$\beta = \beta^0 - \beta_B$$

$$E\,\beta = \frac{1}{l^2} \sum_0^l x\,[l-x]\,w - \frac{1}{l} B_{(M^A=1)} \sum_0^l xyw$$

With the same method of procedure the angles α^a and α^b are obtained, thus

$$E\,\alpha^a = E\,\alpha^b = \sum_0^{l/2} w - B\sum_0^{l/2} yw$$

The following Table II gives the computation of the above angular deformations for the church frame. The general dimensions and division of the arch are shown in the accompanying Fig. 15.

TABLE II

Point	Δs	I	w	y	yw	y^2w	x	$l-x$	xw	$x\,(l-x)w$
1	1.000	∞	0.0000	0.5000	0.000	0.000	0.0	52.0000	0.0	0.0
2	2.000	6.650	0.3006	2.0000	0.601	1.202	0.0	52.0000	0.0	0.0
3	2.000	5.730	0.3490	4 0000	1.396	5.580	0.0	52.0000	0.0	0.0
4	2.000	4.875	0.4100	6.0000	2.460	14.760	0.0	52.0000	0.0	0.0
5	2.833	4.500	0.6300	8.4167	5 300	44.600	0.0	52.0000	0.0	0.0
6	2.833	4.500	0.6300	11.2500	7.090	79.800	0.0	52.0000	0.0	0.0
7	2.833	4.500	0.6300	14.0833	8.880	125.100	0.0	52.0000	0.0	0.0
8	2.833	4.500	0.6300	16.9167	10.660	180.200	0.0	52.0000	0.0	0.0
9	2.833	4.500	0.6300	19.7500	12.450	246.000	0.0	52.0000	0.0	0.0
10	2.833	4.500	0.6300	22.5833	14.220	321.000	0.0	52.0000	0.0	0.0
11	2.500	∞	0.0000	25.2500	0.000	0.000	0.0	52.0000	0.0	0.0
12	2.875	4.500	0.6390	27.9375	17.850	499.000	0.0	52.0000	0.0	0.0
13	2.875	4.500	0.6390	30.8125	19.700	607.500	0.0	52.0000	0.0	0.0
14	2.875	4.500	0.6390	33.6875	21.500	724.100	0.0	52.0000	0.0	0.0
15	2.875	4.500	0.6390	36.5625	23.350	854.000	0.0	52.0000	0.0	0.0
16	2.750	4.695	0.5860	39.3832	23.080	910.000	0.0233	51.9767	0.0130	0.709
17	2.750	5.010	0.5490	42.1398	23.110	975.000	0.2095	51.7905	0.1150	5.950
18	2.750	6.500	0.4230	44.8787	18.980	852.000	0.5811	51.4189	0.2455	12.630
19	2.750	9.060	0.3035	47.5866	14.440	687.000	1.1365	50.8635	0.3450	17.550
20	4.750	7.110	0.6680	51.1937	34.200	1750.000	2.1809	49.8191	1.4560	72.600
21	4.750	3.805	1.2480	55.5910	69.400	3860.000	3.9655	48.0345	4.9550	238.000
22	4.750	3.000	1.5830	59.7511	94.500	5640.000	6.2450	45.7550	9.8900	452.500
23	4.750	3.000	1.5830	63.6235	100.800	6420.000	8.9930	43.0070	14.2300	612.000
24	4.750	3.000	1.5830	67.1500	106.250	7140.000	12.1680	39.8320	19.2500	767.000
25	4.750	3.000	1.5830	70.2865	111.300	7820.000	15.7297	36.2703	24.9000	902 000
26	4.750	3.000	1.5830	72.9905	115.500	8420.000	19.6303	32.3697	31.1000	1005.000
27	4.750	3.000	1.5830	75.2270	119.250	8980.000	23.8203	28.1797	37.7000	1061.000
			20.6710		976.267	57156.842			144.1995	5146.939

Note.—All calculations were made with a 20-inch slide rule. The computations need, on account of symmetry, be made only for half of the frame.

$$B_3 = \frac{\sum_0^{l/2} yw}{\sum_0^{l/2} y^2w} = \frac{976.267}{57156.842} = 0.01708$$

$$E\,\alpha_3{}^a = E\,\alpha_3{}^b = \sum_0^{l/2} w - B \sum_0^{l/2} yw = 20.671 - 0.01708 \times 976.267 = 3.991$$

$$E\,\beta_3 = \frac{2}{l^2} \sum_0^{l/2} x\,[l-x]\,w - \frac{B}{2} \sum_0^{l/2} yw = \frac{2}{52^2} \times 5146.939 - \frac{0.01708}{2} \times 976.267 = -4.535$$

With these values, the locations of the fixed points can now be determined.

As far as the column of the frame to be analyzed is concerned, the restraint at the foot of the column depends on a number of factors, such as the size of the footing on which the column rests and the quality of the soil supporting the footing. It is clear that the angular displacement of such a support cannot be determined mathematically and must be estimated. In this case, the degree of restraint was taken at ⅓ of full restraint and, therefore, a_1 becomes:—

$$a_1 = \frac{l_1 \times \beta_1}{\alpha_1{}^a} \times \frac{1}{3} = \frac{1}{3} \times \frac{15.0 \times 0.288}{0.974} = \mathbf{1.48} \text{ foot}$$

$$\tau_1{}^B = \alpha_1{}^b - \frac{l_1}{l_1 - a_1} \times \beta_1 = 0.564 - \frac{15.0}{15.0 - 1.48} \times 0.288 = 0.245$$

assume $b_2 = 20.00$ feet

$$\tau_2{}^B = \alpha_2{}^a - \frac{l_2}{l_2 - b_2} \times \beta_2 = 5.35 - \frac{52.0}{52.0 - 20.0} \times 2.14 = 1.870$$

$$\epsilon_3{}^B = \tau^B{}_{1-2} = \frac{1}{\frac{1}{\tau_1{}^B} + \frac{1}{\tau_2{}^B}} = \frac{1}{\frac{1}{0.245} + \frac{1}{1.870}} = 0.2168$$

$$a_3 = \frac{l_3 \times \beta_3}{\alpha_3{}^a + \epsilon_3{}^B} = \frac{52.0 \times [-4.535]}{3.991 + 0.2168} = -\mathbf{56.10} \text{ feet}$$

$$\tau_3{}^{B'} = \alpha_3{}^b - \frac{l_3}{l_3 - a_3} \times \beta_3 = 3.991 - \frac{52.0}{52.0 - [-56.10]} \times [-4.535] = 6.171$$

$\tau_1{}^{B'} = \tau_1{}^B = 0.245$ (see above)

$$\epsilon_2{}^{B'} = \tau^{B'}{}_{1-3} = \frac{1}{\frac{1}{\tau_1{}^{B'}} + \frac{1}{\tau_3{}^{B'}}} = \frac{1}{\frac{1}{0.245} + \frac{1}{6.171}} = 0.2358$$

$$b_2 = \frac{l_2 \times \beta_2}{\alpha_2{}^b + \epsilon_2{}^{B'}} = \frac{52.0 \times 2.14}{5.35 + 0.2358} = \mathbf{19.90} \text{ feet}$$

This value is so close to the previously assumed value of 20 feet, that the calculation does not have to be repeated. The remaining values can therefore be computed.

$$\epsilon_1{}^{B'} = \tau^{B'}{}_{2-3} = \frac{1}{\frac{1}{\tau_2{}^{B'}} + \frac{1}{\tau_3{}^{B'}}} = \frac{1}{\frac{1}{1.87} + \frac{1}{6.171}} = 1.435$$

$$b_1 = \frac{l_1 \times \beta_1}{\alpha_1{}^b + \epsilon_1{}^{B'}} = \frac{15.0 \times 0.288}{0.564 + 1.435} = \mathbf{2.16} \text{ feet}$$

The carry over coefficients are obtained directly, as all τ values are already known from the calculation of the position of the fixed points.

$$\left.\begin{aligned} \mu_{1-2} &= \frac{\tau^B{}_{2-3}}{\tau_2{}^B} = \frac{1.435}{1.87} = 0.767 \\ \mu_{1-3} &= \frac{\tau^B{}_{2-3}}{\tau_3{}^B} = \frac{1.435}{6.171} = 0.233 \end{aligned}\right\} = 1.000$$

$$\left.\begin{aligned} \mu_{2-1} &= \frac{\tau^B{}_{1-3}}{\tau_1{}^B} = \frac{0.2358}{0.245} = 0.962 \\ \mu_{2-3} &= \frac{\tau^B{}_{1-3}}{\tau_3{}^B} = \frac{0.2358}{6.171} = 0.038 \end{aligned}\right\} = 1.000$$

$$\left.\begin{aligned} \mu_{3-1} &= \frac{\tau^B{}_{1-2}}{\tau_1{}^B} = \frac{0.2168}{0.245} = 0.884 \\ \mu_{3-2} &= \frac{\tau^B{}_{1-2}}{\tau_2{}^B} = \frac{0.2168}{1.870} = 0.116 \end{aligned}\right\} = 1.000$$

To obtain the carry over coefficient, with which the moments of bracket 4 have to be multiplied to obtain the balancing moments of members 1, 2 and 3, the value $\tau^B{}_{1-2-3}$ has to be obtained first.

$$\tau^B{}_{1-2-3} = \frac{1}{\frac{1}{\tau_1{}^B} + \frac{1}{\tau_2{}^B} + \frac{1}{\tau_3{}^B}} = \frac{1}{\frac{1}{0.245} + \frac{1}{1.87} + \frac{1}{6.171}} = 0.2095$$

$$\left.\begin{aligned} \mu_{4-1} &= \frac{\tau^B{}_{1-2-3}}{\tau_1{}^B} = \frac{0.2095}{0.245} = 0.854 \\ \mu_{4-2} &= \frac{\tau^B{}_{1-2-3}}{\tau_2{}^B} = \frac{0.2095}{1.870} = 0.112 \\ \mu_{4-3} &= \frac{\tau^B{}_{1-2-3}}{\tau_3{}^B} = \frac{0.2095}{6.171} = 0.034 \end{aligned}\right\} = 1.000$$

The location of all fixed points and the values of all carry over coefficients are shown in Fig. 9.

Moment due to Dead Loads of centre beam 2. (Fig. 16.)

The uniformly distributed dead load on beam 2 is:—

Slab. "Floortyle," 8″ + 2″	= 13 × 50 lbs. =	650 pounds
T-beam	= 4 × 0.833 × 150 lbs. =	500 "
	= 1.5 × 1.833 × 150 lbs. =	412 "
Suspended ceiling	= 17 × 10 lbs. =	170 "
Tile floor finish	= 17 × 25 lbs. =	425 "
		2,157 pounds per lin. foot of beam.

The procedure of distributing the bending moments due to the above dead load as given analytically below can

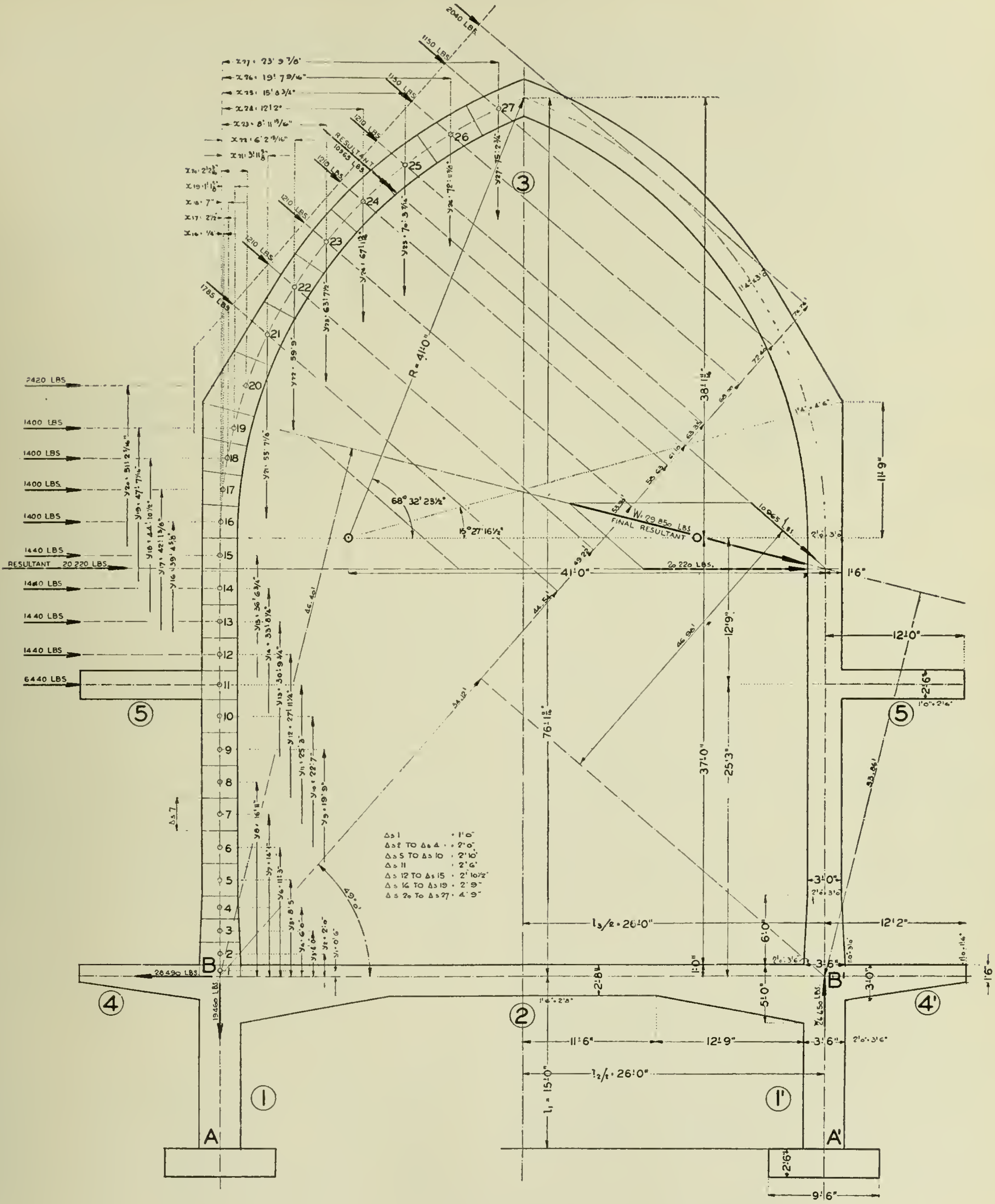


Fig. 15.

easily be followed step by step in Fig. 16 which illustrates the graphical solution.

Assume member 2 freely supported at both ends and compute the maximum bending moment due to the dead load, thus

$$M^0 = \frac{2157 \times 52^2}{8} = 730{,}000 \text{ foot-pounds}$$

To obtain the negative moments due to the restraint at both supports of member 2, a line is drawn from the support to the point of maximum moment (centre of beam) and the intersection of this line with a perpendicular drawn through the fixed point indicates the extent to which the closing line of the moment polygon is lowered (see line 1), or analytically

$$M_2^B = \frac{M^0 \times a_2}{\frac{1}{2}\, l_2} = \frac{730{,}000 \times 19.90}{26.0}$$
$$= -\,558{,}000 \text{ foot pounds} = M_2^{B'}$$

These two moments have to be carried over to members 3 and 1, and from joint to joint of the frame, until the remaining moments are so small as to be negligible. This process can be carried out graphically or analytically. It is usually best to do it in both ways to obtain an independent check of the figures. The analytical procedure is as follows:

(In Fig. 16, the moments are always indicated on the side of the frame axis where tension would be caused by

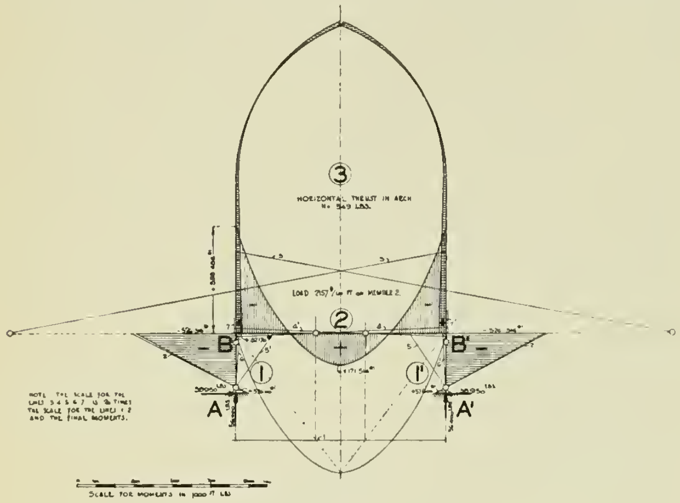


Fig. 16.

such moment). Take moment $M_2{}^B$ at point B and obtain $M_1{}^B$ and $M_3{}^B$ thus

$$M_1{}^B = M_2{}^B \times \mu_{2-1} = 558{,}000 \times 0.962 = 536{,}800$$

$$M_3{}^B = M_2{}^B \times \mu_{2-3} = 558{,}000 \times 0.038 = 21{,}200$$

Moment $M_3{}^B$ is carried over to B' and reduced to $M_3{}^{B'}$ (see line 3).

$$M_3{}^{B'} = \frac{M_3{}^B \times b_3}{l_3 - b_3} = \frac{21{,}200 \times 56.10}{52.0 - [-56.10]} = 11{,}000 \text{ foot-pounds}$$

The result is carried over to members 1 and 2 again thus:—

$$M_1{}^{B'} = M_3{}^{B'} \times \mu_{3-1} = 11{,}000 \times 0.884 = 9724 \text{ foot-pounds}$$

$$M_2{}^{B'} = M_3{}^{B'} \times \mu_{3-2} = 11{,}000 \times 0.116 = 1276 \text{ foot pounds}$$

The moment 1276 foot-pounds is carried over beam 2 by drawing a line through fixed point J_2 and we obtain (see line 4)

$$M_2{}^B = \frac{1276 \times a_2}{l_2 - a_2} = \frac{1276 \times 19.90}{52.0 - 19.90} = 790 \text{ foot-pounds}$$

This moment is carried over to members 1 and 3 again thus

$$M_1{}^B = 790 \times \mu_{2-1} = 790 \times 0.962 = 760 \text{ foot-pounds}$$

$$M_3{}^B = 790 \times \mu_{2-3} = 790 \times 0.038 = 30 \text{ foot-pounds}$$

The latter moment is small enough to be negligible. The process has to be repeated now for the end restraint of beam 2 at point B' or $M_2{}^{B'}$, and after this, all moments can be added to obtain the final moments in the frame due to the dead load on beam 2. The easiest way to sum up these moments is to use the diagram as a basis, and to tabulate the values thus:

$$M_1{}^B = -536{,}800 + 760 + 9724 = -526{,}316 \text{ foot-pounds} = M_1{}^{B'}$$

$$M_2{}^B = -558{,}000 - 1276 + 790 = -558{,}486 \text{ foot-pounds} = M_2{}^{B'}$$

$$M_3{}^B = +21{,}200 - 30 + 11{,}000 = +32{,}170 \text{ foot-pounds} = M_3{}^{B'}$$

As a check, the two moments $M_1{}^B$ and $M_3{}^B$ have to balance the moment $M_2{}^B$ and we should have

$$M_2{}^B - [M_1{}^B + M_3{}^B] = 0$$

or

$$+558{,}486 - [526{,}316 + 32{,}170] = 0$$

The horizontal thrust in the arch, due to the bending moments at both supports amounts to

$$H = M_3{}^B \times \frac{B}{2} + M_3{}^{B'} \times \frac{B}{2} = 32{,}170 \times 0.01708 = 549 \text{ pounds}$$

The final bending moments at any point of the arch is

$$M_x = 32{,}170 - 549\,y$$

Dead Load Moments in Arch. (Fig. 17.)

To determine the moments in the frame due to the dead loads of the arch, it is necessary first to calculate the bending moments of these loads applied on the principal system, or statically determinate system, for every section of the arch. (See M^0 line in Fig. 17.)

The loads applied at each point of the arch are as follows:—

Table III

Dead Loads Member 3

Points 1 to 15	34,200 pounds
Point 16	2,575 pounds
17	2,490 pounds
18	2,540 pounds
19	2,635 pounds
20	8,775 pounds
21	8,175 pounds
22	8,135 pounds
23	8,240 pounds
24	8,340 pounds
25	8,440 pounds
26	8,540 pounds
27	9,060 pounds
	112,145 pounds

To obtain the M^0 moments for each point, a time-saving method is to use the formula

$$M^0_{20} = A\,x_{20} - \overbrace{[M^P_{19} + Q_{19}\underbrace{[x_{20} - x_{19}]}_{a}]}^{M^P}$$

The above formula gives, for instance, the moment required for point 20. The notations used are illustrated in Fig. 17, and are self explanatory. The main advantage of this method is that for each subsequent moment to be computed, the moment previously determined can be used again. In the following Table, A is taken as 77,945 pounds representing the dead loads 16 to 27. The loads 1 to 15 can temporarily be neglected as they do not contribute to the moments to be computed.

Table IV

M^0 Moments in Arch (Member 3)

A = 77,945 pounds is constant

Point	x	Ax	M^P	Q	a	Qa	M^P	M^0
1 to 15	0	0	0	0	0	0	0	0
16	0.0233	1790	0	0	0	0	0	1790
17	0.2095	16300	0	2575	0.1862	480	480	15820
18	0.5811	45250	480	5065	0.3716	1885	2365	42885
19	1.1365	88500	2365	7605	0.5554	4220	6585	81915
20	2.1809	170000	6585	10240	1.0444	10700	17285	152715
21	3.9655	309000	17285	19015	1.7846	33900	51185	257815
22	6.2450	487000	51185	27190	2.2795	61950	113135	373865
23	8.9930	700000	113135	35325	2.7480	97100	210235	489765
24	12.1680	947000	210235	43565	3.1750	138200	348435	598565
25	15.7297	1250000	348435	51905	3.5617	184900	533335	716665
26	19.6303	1530000	533335	60345	3.9006	235000	768335	761665
27	23.8203	1855000	768335	68885	4.1900	288500	1056835	**798165**
27′	28.1797	2195000	1056835	77945	4.3594	339500	1396335	**798665**
					28.1797			

For a check, the sum under column "a" must be equal to $x_{27'}$, $Q_{27'}$ must be equal to A, and M^0_{27} must be equal to $M^0_{27'}$ on account of symmetry. The difference between the two latter moments is only 0.06 per cent which is accurate enough.

In order to obtain the moments of restraint at both supports of the arch, the following equations have to be solved.

$$k_3{}^a = -\frac{\phi_3{}^b}{\beta_3} \qquad k_3{}^b = -\frac{\phi_3{}^a}{\beta_3}$$

in which β is already known, and both values $\phi_3{}^b$ and $\phi_3{}^a$ represent the angular deformations of both supports of the two-hinged arch due to the external loading (see Fig. 12).

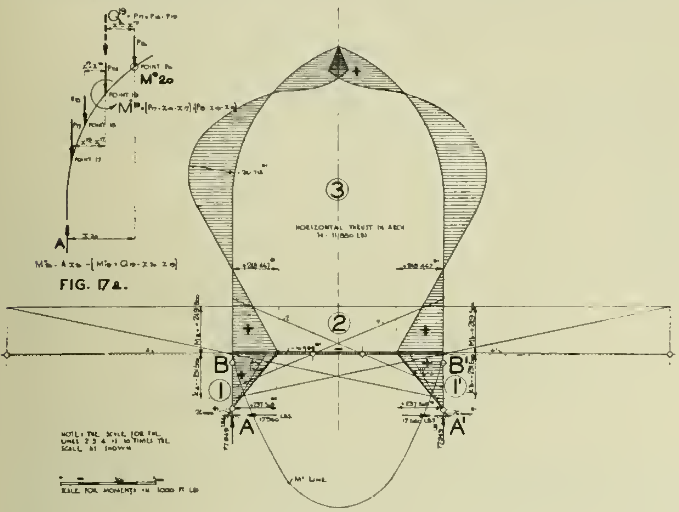


Fig. 17.

When both values k^a and k^b are known, the moments of restraint are easily obtained as shown in Fig. 17 in the following manner: indicate the distance k^a and k^b below joints B and B' respectively. Draw from the two points thus found a line through the opposite joint until the line intersects with a perpendicular drawn from the fixed points of the arch. Connect these two points of intersection with a line which in this particular case happens, on account of symmetry, to be horizontal. This latter line cuts off, at the supports, the moments of restraint $M_3{}^B$ and $M_3{}^{B'}$ which are measured in the same scale as used to plot the values k^a and k^b.

The formulae for the above angular deformations ϕ^a and ϕ^b are derived in exactly the same way as was shown previously for the value β and are

$$E\,\phi_3{}^a = \frac{1}{l_3}\sum_0^{l_3} M^0\,[l_3 - x]\,w - \frac{H}{2}\sum_0^{l_3} yw$$

$$E\,\phi_3{}^b = \frac{1}{l_3}\sum_0^{l_3} M^0\,xw - \frac{H}{2}\sum_0^{l_3} yw$$

in which H represents the horizontal thrust of the two-hinged arch due to the external loading.

$$H = \frac{\sum_0^{l_3} M^0\,yw}{\sum_0^{l_3} y^2 w}$$

The computation of these values to obtain k^a and k^b is given in the following table.

TABLE V

Point	M^0	yw	M^0yw	xw	$[l-x]w$	M^0xw	$M^0[l-x]\,w$
0-15	0						
16	1790	23.080	41300	0.0130	30.410		54500
17	15820	23.110	366000	0.1150	28.400	1800	449000
18	42885	18.980	814000	0.2455	21.750	10500	932000
19	81915	14.440	1180000	0.3450	15.450	28300	1265000
20	152715	34.200	5225000	1.4560	33.300	222300	5090000
21	257815	69.400	17900000	4.9550	60.000	1278000	15480000
22	373855	94.500	35300000	9.8900	72.450	3695000	27009000
23	489765	100.800	49350000	14.2300	68.050	6960000	33300000
24	598565	106.250	63600000	19.2500	63.050	11520000	37710000
25	691665	111.300	76800000	24.9000	57.400	17200000	39650000
26	761665	115.500	87950000	31.1000	51.250	23650000	39000000
27	798200	119.250	95200000	37.7000	44.600	30100000	35600000
			433726300			94665900	235539500
							94665900
							330205400

$$H = \frac{433{,}726{,}300}{57{,}156} = 7600 \text{ pounds}$$

$$E\,\phi^a = E\,\phi^b = \frac{330{,}205{,}400}{52} - \frac{7600}{2} \times 2 \times 976.26 = -1{,}070{,}000$$

$$k^a = k^b = -\frac{-1{,}070{,}000}{-4.535} = -236{,}000 \text{ foot-pounds}$$

$$M_3{}^B = M_3{}^{B'} = \frac{k_3{}^a}{l_3} \times b_3 = \frac{-236{,}000 \times [-56.10]}{52.0} = +254{,}500 \text{ foot-pounds}$$

Both these moments have to be carried around the frame again in a similar manner as shown for the moments due to the dead loads of the beam. It is best to begin again at joint B.

$$\left.\begin{aligned} M_1{}^B &= M_3{}^B \times \mu_{3-1} = 254{,}500 \times 0.884 = 225{,}000 \\ M_2{}^B &= M_3{}^B \times \mu_{3-2} = 254{,}500 \times 0.116 = 29{,}500 \end{aligned}\right\} = 254{,}500$$

$$M_2{}^{B'} = \frac{M_2{}^B \times b_2}{l_2 - a_2} = \frac{29{,}500 \times 19.90}{52.0 - 19.90} = 18300 \qquad \text{(see line 2)}$$

$$\left.\begin{aligned} M_1{}^{B'} &= M_2{}^{B'} \times \mu_{2-1} = 18{,}300 \times 0.962 = 17{,}604 \\ M_3{}^{B'} &= M_2{}^{B'} \times \mu_{2-3} = 18{,}300 \times 0.038 = 696 \end{aligned}\right\} = 18{,}300$$

$$M_3{}^B = \frac{M_3{}^{B'} \times a_3}{l_3 - a_3} = \frac{696 \times 56.10}{52 - [-56.10]} = 361 \qquad \text{(see line 4)}$$

$$\left.\begin{aligned} M_1{}^B &= M_3{}^B \times \mu_{3-1} = 361 \times 0.884 = 319 \\ M_2{}^B &= M_3{}^B \times \mu_{3-2} = 361 = 0.116 = 42 \end{aligned}\right\} = 361$$

The remaining value of $M_2{}^B = 42$ foot-pounds is small enough, so that the distribution of the original moment $M_3{}^B = 254{,}500$ foot-pounds can stop here. The moment $M_3{}^{B'} = 254{,}500$ foot-pounds has also to be carried around the frame until the remaining moment is so small that it can be neglected. On account of symmetry, this distribution gives identical values as the moments distribution shown above for $M_3{}^B$.

The result can be added up to obtain the final moments at the joints B and B'. This summation can best be done by using the diagram No. 17 as guide in order to eliminate a possible error of signs.

$$M_1{}^B = M_1{}^{B'} = 225000 + 17604 - 319 = 242285 \text{ foot-pounds}$$

$$M_2{}^B = M_2{}^{B'} = -29500 + 18300 - 42 = -11158 \text{ foot-pounds}$$

$$M_3{}^B = M_3{}^{B'} = 254500 - 696 - 361 = 253443 \text{ foot-pounds}$$

The two moments $M_2{}^B$ and $M_1{}^B$ have to balance the value $M_3{}^B$ if the result is correct, thus $242285 + 11158 - 253443 = 0$. In order to obtain the bending moments at any point of the arch, it is necessary that the final horizontal thrust be known. To the thrust of 7,600 pounds previously computed, which represents the thrust due to the dead loads of the two hinged arch, has to be added the thrust due to both end moments of restraint $M_3{}^B$ and $M_3{}^{B'}$. This additional thrust is very easily obtained by multiplying both moments by half the value of B. Therefore:

$$H \text{ final} = H + \frac{B}{2}\,(M_3{}^B + M_3{}^{B'})$$

or H final $= 7600 + 0.01708 \times 253443 = 11930$ pounds.

The following Table VI indicates the method of computing the final bending moments for the various points of the arch.

Table VI

Dead Load Moments in Arch

Point	$+M^0$	$+M_3{}^B = M_3{}^{B'}$	$-Hy$	M final
0	0	253443	0	+253443
11	0	253443	−301000	− 47557
12	0	253443	−333000	− 79557
13	0	253443	−368000	−114557
14	0	253443	−401500	−148057
15	0	253443	−436000	−182557
16	1790	253443	−470000	−214767
17	15820	253443	−503000	−233737
18	42885	253443	−535000	−238672
19	81915	253443	−567000	−231642
20	152715	253443	−610000	−203842
21	257815	253443	−663000	−151742
22	373855	253443	−712000	− 84702
23	489765	253443	−760000	− 16792
24	598565	253443	−801000	+ 51008
25	691665	253443	−838000	+107108
26	761665	253443	−870000	+145108
27	798200	253443	−898000	+153643

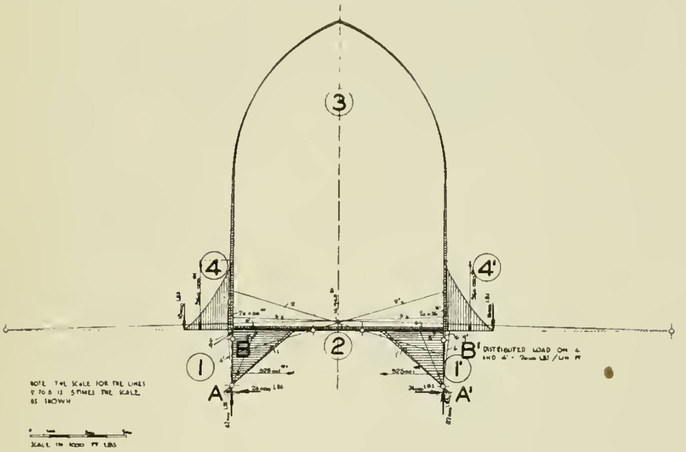


Fig. 18.

Moments due to dead loads on brackets 4. (See Fig. 18.)

The bending moment at the support of the bracket 4 due to the dead loads amounts to:

$$18000 \times 12.0 = 216000$$

$$2000 \times \frac{12^2}{2} = 144000$$

$$\text{Total } M_4{}^B = M_4{}^{B'} = 360000 \text{ foot-pounds}$$

This moment is carried over into the members 1, 2 and 3, and around the frame (as shown previously). See the following table:—

Table VII

	$M_1{}^B$	$M_2{}^B$	$M_3{}^B$	$M_1{}^{B'}$	$M_2{}^{B'}$	$M_3{}^{B'}$	See Fig. 18
360000 × 0.854	+307450						line 1
360000 × 0.112		−40300					line 2
360000 × 0.034			−12250				line 3
12250 × 56.10						−6360	line 3
108.10							
6360 × 0.884				− 5622			line 4
6360 × 0.116					+ 738		line 5
738 × 19.90		− 458					line 5
32.10							
458 × 0.962	− 441						line 6
458 × 0.038			+ 17				
40300 19.90					+25000		line 2
32 10							
25000 × 0.962				+24050			line 7
25000 × 0.038						− 950	line 8
950 56.10			− 493				line 8
108.10							
493 × 0.884	− 436						line 9
493 × 0.116		+ 57					
	+306573	−40701	−12726	+ 18428	+25738	− 7310	
Bracket 4'	+ 18428	+25738	− 7310	+306573	−40701	−12726	
Total moments	+325001	−14963	−20036	+325001	−14963	−20036	

Verify

$$M_1{}^B = M_1{}^{B'} = 325001$$
$$M_2{}^B = M_2{}^{B'} = 14963$$
$$M_3{}^B = M_3{}^{B'} = 20036$$

$$M_4{}^B = M_4{}^{B'} = 360000 \text{ foot-pounds}$$

The horizontal thrust $H = 0.01708 \times 20036 = 342$ pounds. The bending moment at any point in the arch amounts to

$$M_x = M_3{}^B - Hy$$
$$M_x = 20036 - 342\,y.$$

Moments due to dead loads on brackets 5 and 5'. (Fig. 19.)

The uniformly distributed load on the brackets is

Slab	= 50 × 17′ 0″ =	850
Roofing	20 × 17′ 0″ =	340
Beam		300
Ceiling	10 × 17′ 0″ =	170
		1,660 pounds per lin. foot of bracket.

The bending moment at the support of the bracket

$$M = 1{,}660 \times \frac{12^2}{2} = -119{,}500 \text{ foot-pounds}$$

The moments in the statically determinate system are zero for all points from the arch support B and B' to point 11, and 119,500 foot-pounds for the points 11 to 27 inclusively. The following table indicates the computation of all values required to obtain the end moments at both supports of the continuous arch.

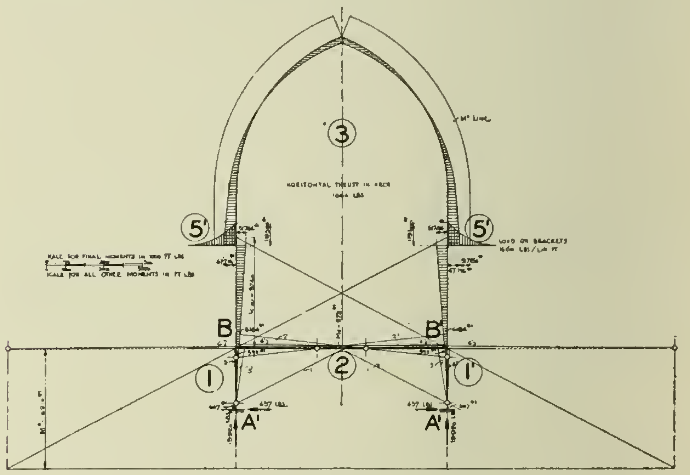


Fig. 19.

Table VIII

Point	yw	xw	$(l-x)\,w$
1 to 10 neglected as $M^0 = 0$			
11	0.00	0	0
12	17.850	0	33.200
13	19.700	0	33.200
14	21.500	0	33.200
15	23.350	0	33.200
16	23.080	0.0130	30.410
17	23.110	0.1150	28.400
18	18.980	0.2455	21.750
19	14.440	0.3450	15.450
20	34.200	1.4560	33.300
21	69.400	4.9550	60.000
22	94.500	9.8900	72.450
23	100.800	14.2300	68.050
24	106.250	19.2500	63.050
25	111.300	24.9000	57.400
26	115.500	31.1000	51.250
27	119.250	37.7000	44.600
	$\sum_{11}^{27} yw = 913.21$	$\sum_{0}^{27} = 144.1995$	$\sum_{11'}^{27'} = 678.910$
			144.199
			$\sum_{11}^{11'} = 823.109$

$$H = \frac{\sum_0^l M^0 yw}{\sum_0^l y^2 w} = \frac{-119{,}500 \times 913.21}{57{,}156} = -1910 \text{ pounds}$$

$$\varphi^a = \varphi^b = \frac{\sum_0^l M^0 xw}{l} - \frac{H}{2}\sum_0^l yw$$

$$= \frac{-119{,}500 \times 823.109}{52} - \left[\frac{-1910}{2} \times 2 \times 976.26\right]$$

$$= -26{,}000$$

$$k^a = k^b = -\frac{\varphi^a}{\beta} = -\frac{-26{,}000}{-4.535} = -5740 \text{ foot-pounds}$$

$$M_3{}^B = M_3{}^{B'} = \frac{-5740 \times [-56.10]}{52} = +6210 \text{ foot-pounds}$$

These two moments are again carried around the frame to obtain the final moments at each joint. The process can easily be followed on Fig. 19. The resulting moments are

$$M_3{}^B = M_3{}^{B'} = +6184 \text{ foot-pounds}$$
$$M_2{}^B = M_2{}^{B'} = -273 \text{ foot-pounds}$$
$$M_1{}^B = M_1{}^{B'} = +5911 \text{ foot-pounds}$$

The final horizontal thrust in the arch is

$$H = -1910 + 6184 \times 0.01708 = -1804 \text{ pounds}$$

The final bending moments at any point of the arch are now as follows:—

$$M_1{}^B = M_1{}^{B'} = +6184 \text{ foot-pounds}$$

The moment at point 11 immediately below the brackets (5)

$$= +6184 - (-1804 \times 25.25) = +51784 \text{ foot pounds}$$

The moment at point 11 immediately above the bracket 5

$$= +6184 - (-1804 \times 25.25) - 119500$$
$$= -67716 \text{ foot-pounds}$$

For the moments at points 12 to 27 and 12′ to 27′ the following formula applies:

$$M = +6184 - (-1804 \times y) - 119500.$$

The table below gives all bending moments for the points 12 to 27.

Table IX

Point	M in foot-pounds	Point	M in foot-pounds	Point	M in foot-pounds
12	−62800	18	−32300	24	+ 7700
13	−57700	19	−27300	25	+13700
14	−52500	20	−20900	26	+18200
15	−47300	21	−12700	27	+22480
16	−42200	22	− 5500	centre	+24180
17	−37200	23	+ 1700		

These final moments due to dead loads on brackets 5 and 5′ are shown in Fig. 19.

(To be continued)

Note:—Symbol ϕ used in text on page 379 is shown on Diagrams as symbol φ.

Design and Application of Gears

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Paper presented before the Montreal Branch of the Engineering Institute of Canada, December 6th, 1934.

SUMMARY.—In the following paper the general problems encountered by the designer of gears are discussed and also the best methods of overcoming these with the present empirical and theoretical data available.

While apparently a pair of gears making conjugate action and transmitting power appears to be one of the simplest forms of mechanism, the satisfactory power drive through gearing is an intricate problem in machine design.

The gear designer first of all has to determine the load to be transmitted. From a straight horsepower formula the direct load can be simply determined but other loads occur on the gear teeth which, although they bear a relation to the transmitted load, are due to dynamic forces, and are not so readily estimated. The dynamic loads are of possibly greater importance in the design of gears than the actual transmitted loads. Considerable research has been done within the last five years on the magnitude of these loads and information is now available which has not been in the past. The designer, therefore, has first to determine the probable loads on the gear teeth, which involves a study of theoretical dynamics, and next to consider the materials which are available to carry these loads. This involves a study of metallurgy because the failure of the material on the surface of the teeth is usually due to structural failure in the material itself due to fatigue in shear.

The gear designer next investigates the solid geometry of the gear teeth to study the effects of tooth shape proportions, as the solid geometry of the gear teeth has a direct bearing on their ability to carry loads. He then considers the methods to be used in the machine shop to reproduce the conclusion arrived at, and this requires a thorough understanding of the practical side of gear cutting. The conditions under which the gear will operate must be considered, such as the accuracy with which it will be held in its relationship to the mating gear; the ability of the supporting structure to carry the loads imposed on the gearing without too much distortion, which would affect the tooth contact and the ability of the gear to satisfactorily transmit the predetermined loads. Further, he must also consider the protection to be given the gears from what might be termed outside interference. They must be enclosed in a case which will prevent foreign matter, both large and small, from interfering with the proper action of the contacting surfaces. Finally, he must consider the problem of lubrication between the gear surfaces themselves and its relationship to loads imposed.

It will be seen from the foregoing that the designer of gears must have a thorough basic knowledge in a good many normally unrelated branches of mechanical engineering, and the success of his design will be governed largely by his ability to handle the mathematical and practical tools at his disposal. While the general machine designer uses, and always will use, gears in his design which he will feel free to choose and install according to his own judgment, nevertheless, in its highest development, gearing is a subject for the specialist, and the most economical and satisfactory service will be obtained from gearing which has been designed by engineers with an adequate background of knowledge and experience.

In the past, gearing has been regarded by machine designers as a nuisance to be avoided wherever possible or to be handled with resignation. In recent years the development of gear design, and, more particularly, the development of machinery to reproduce the design accurately has resulted in gears being used to a much greater extent than previously and for more particular requirements. It is possible to interconnect machines by means of gearing which normally, for reasons of their own efficiency, should run at different speeds, to make a more satisfactory and economical overall installation than would be possible if a compromise in speed had to be effected between the driver and the driven machines. As an illustration of this, marine propulsion by means of steam turbines is today almost exclusively done through gearing. The large and costly low speed turbine has been replaced by a high speed turbine operating at its normal speed. The high rotative speeds used in propellers driven by direct connected turbines have also been abandoned and the propellers today operate at their economical speed regardless of the speed of the turbine. Gearing is used to interconnect water wheels to generators and pumps so that the two individual machines can be operated at their most economical speed.

In view of the extent of the subject this paper will be confined to a study of gearing with parallel shafts as the general problems involved are common to other types.

Gear Tooth Forms

The first problem in the design of gearing is the tooth form which the gear will have when it is installed. A thorough discussion of the various curves which could be used would take too much time; however, an attempt will be made to point out the high points in the various systems used without going into detail. The problem in gearing is to transmit rotary motion from one shaft to another, usually with a reduction or increase of speed, but at all times in such a manner that the angular velocity as against time is a constant regardless of the actual teeth in the gear. The ideal, of course, would be two cylinders running in contact with gear teeth so small that they will practically be the molecular surface of the two cylinders. Such an arrangement would give a high degree of accuracy but would transmit little load.

Gear tooth forms can be subdivided into two types, those having symmetrical action on each side of the pitch point, which is the point of tangency between the two pitch circles, and those in which the action is all on one side of the pitch point. In the first category lie practically all gears with which the average engineer is familiar, and only a few special forms are now made of the other type. All systems of tooth curvature can be referred back to a theoretical rack shape, such a shape being the ideal rack which would mesh with the gear in question. The theoretical rack in the case of the cycloidal gear would have curved surfaces which would be complements of each other above and below the pitch line. This rack would generate a form of gearing which would have perfect conjugate action only under such conditions that the pitch circles were truly tangential. The cycloidal form of teeth is definitely limited to its designed centre distance and any departure from the exact centre distances for which the gears are constructed will result in irregular action, noise, and rapid wear of the gears. The involute curve, however, which is generated by a rack having a straight side will operate under varying conditions of centre distance and give a perfectly regular tooth action at varying centres. The involute curve is the only curve having this property and it is for this reason that it is so widely used in modern gearing. It is possible to get involute gearing which will operate correctly on any centres from the point where the teeth interfere on the back faces out to the point where the teeth barely touch. The regular involute action and the theoretical constant transmission of angular velocity will not be lost. It is possible to cut involute gearing of widely varying shapes with the same cutter and operating with widely varying pressure angles which will be perfectly interchangeable and will operate with each other giving perfect tooth contact and angular transmission of load. As an illustration of this, Fig. 1 shows four gears, all of which are of the same outside diameter and cut with the same cutter, the numbers of teeth varying from 18 to 21 inclusive, and all of which will mesh and operate perfectly with each other.

In the unsymmetrical group, the best known example is the Vickers-Bostock type of gear tooth, which is widely used in turbine reduction gearing in England. This type of gear, due to the concave shape of the teeth in the gear, and to the fact that the pinion teeth gain a more complete contact with such a gear tooth shape, is widely used where the horsepower to be transmitted is high. This type of tooth is generated by a rack having a curved surface, all of which is on one side of the pitch line. The curved sur-

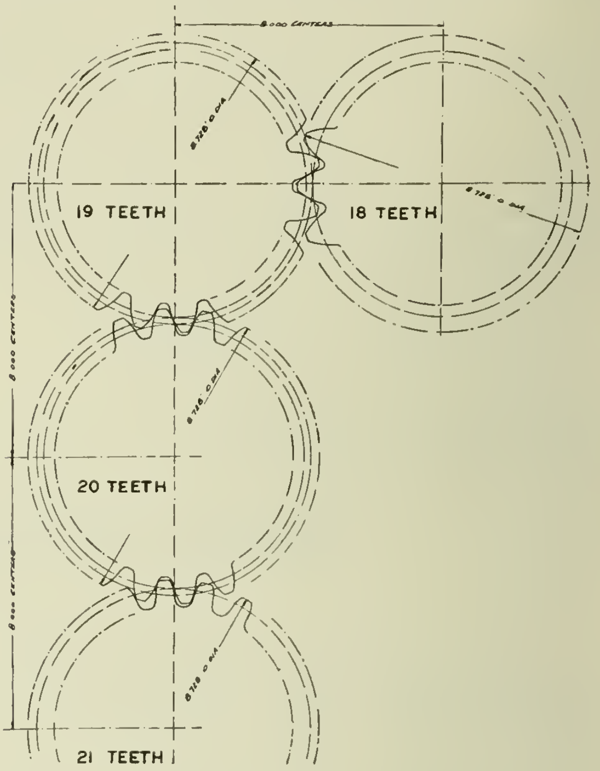

Fig. 1.

face of the rack is a combination of involute and cycloidal curves, and theoretically it requires two racks, one of which is a complement of the other, to generate the surfaces of the two gears. Due to these requirements, this system involves excessive tool cost. It also suffers from the disadvantage that the gears must be operated on exactly fixed centres for perfect tooth action, and is not generally adopted for what might be called commercial gear reducers.

The load carrying capacity of gears depends largely on the curvature of the tooth surfaces in contact. It will be obvious that, while the actual contact takes place on a line which is the point of tangency of the two curves, due to the elastic deformation of the materials used, the contact is actually spread over an area, the width of which bears some relation to the degree of curvature on each tooth and to the load. As the involute curve alters its radius from the base circle out, the rate of change of curvature is more rapid adjacent to the base circle, and this is called the "sensitive" part of the involute. Not only is the rate of change of curvature sensitive but the actual radius of curvature at this point is much smaller than further out from the base circle. For this reason there has been a tendency in recent years to depart from the old fashioned 14½-degree pressure angle and to adopt a pressure angle of 20 degrees and sometimes more, with the object of achieving contact on a less sensitive part of the involute and where the radius of curvature is greater. Of course, the use of a larger pressure angle increases the actual contact load due to the fact that the actual load contact between the teeth is proportional to the diameter of the base circle from which the involute is struck and for any given pitch diameter the base circle will be smaller as the pressure angle increases. It would seem to be poor practice to increase the load by the use of a larger pressure angle but actually it is advisable to do so to obtain a much greater increase in the load carrying capacity of the gear teeth themselves due to a larger average radius of curvature. Another consideration which is of importance is the strength of the teeth themselves. The greater pressure angle gives the pinion a stronger tooth and this has led to the use of higher pressure angles.

Stronger pinion teeth can also be obtained by modification of the addendums of the gear and pinion. It is quite a common practice among gear manufacturers today to make the addendum of the pinion longer than the addendum of the gear. This results in a stronger pinion tooth and utilizes the involute curve further away from the base circle, resulting in a greater average radius of curvature at the points of contact. From practical considerations, however, considering the relationship between the sliding and rolling contact, the modified addendum systems should only be used with gears having efficient lubrication, because the average sliding contact as compared to the rolling contact will be greater with the enlarged pinion than with the older type of symmetrical gear. For this reason, it is common practice to recommend the symmetrical type with equal addendums on the gear and pinion for exposed gearing where the lubrication tends to be inadequate, and to use the modified addendum ratio only in cases where the lubrication will be perfect.

Now to consider the various forms of gears such as spur, helical, double helical, etc. The great advance in load carrying capacity and quietness in modern gearing is undoubtedly due to the development of the machinery for generating the various forms of helical gears. A pair of spur gears with teeth parallel to their axes can be generated to give an absolutely regular transmission of angular velocity. Theoretically, however, this condition can only be obtained at no load because as soon as the gear is loaded the teeth themselves deflect and, due to the fact that in spur gears of this type the transmission of load takes place from tooth to tooth with sometimes only one on contact, tooth deflection makes it impossible to

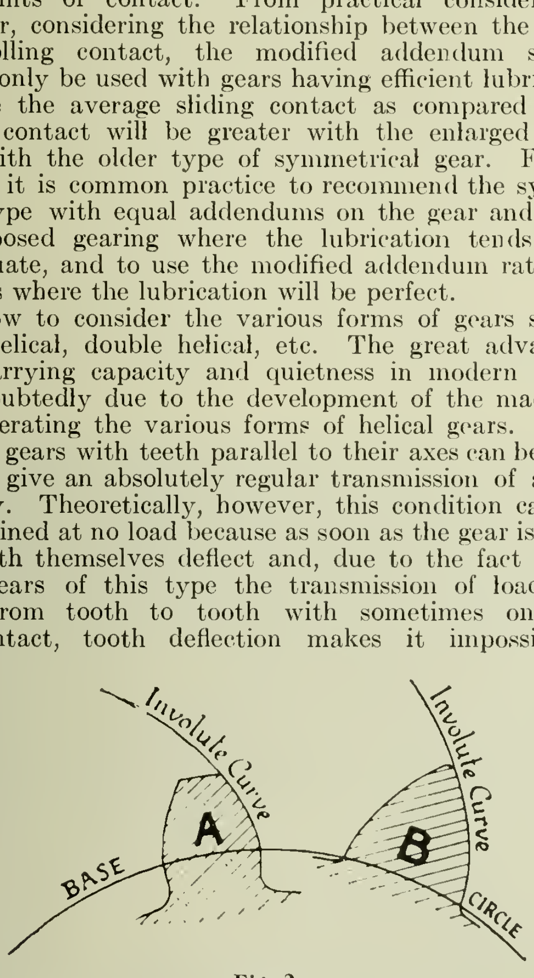

Fig. 2.

Both these teeth are for a 12-tooth pinion, generated to the involute curve from a common base circle.
A is the usual shape, and 14½ degrees pressure angle.
B has increased addendum and increased pressure angle, and uses more of the involute curve than does tooth A.
Both teeth are cut by the same cutter.

obtain the theoretical perfect angular transmission of power with any reasonable loading on the gear teeth.

In some of the more highly developed types of spur gears forms of teeth are used today having a modified tooth shape to make up for the tooth deflection, but such forms are a compromise and can only be generated to transmit power uniformly under definite set conditions of load. It is for this reason that the helical gear has come into its own in recent years, although high grade spur gears are still used, and always will be used, for specific purposes.

Due to the fact that the load per tooth varies on a spur gear as it is transmitted from one tooth to another, the wear also varies and the tendency for the spur gear is to lose its perfect tooth shape from wear. The old idea of running a pair of gears together to run them in was wrong, the only wear which can take place on a spur gear will be in the direction of destruction of the perfect tooth form and

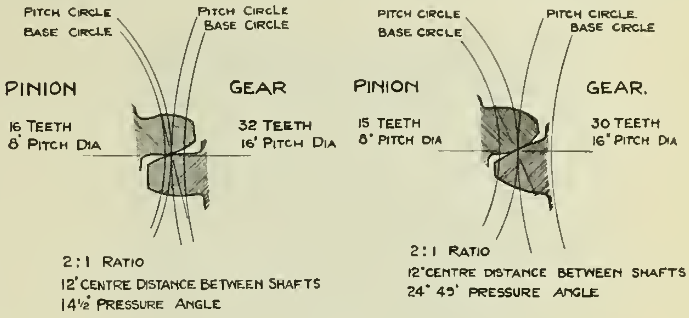

Fig. 3.

it is much better to use a form of gearing which has not this disadvantage.

Contrary to the above, helical gearing, when properly designed and cut, transmits its load from tooth to tooth with practically no change of the number of teeth in contact. As a result, the helical gear is quiet and the wear from operation shows little tendency to depart from the true generated shape.

There is really little difference in action between the single helical and the herringbone type of gear. The tooth overlap, due to the helix, will be the same with the single helical as with the double helical if the helix angle on the first is half that on the latter, assuming, of course, that the face widths, tooth proportions, etc. are the same. The essential difference between these types, however, is that for practical helix angles, the single helical gear develops thrust which must be taken up externally to the gears. The double helical or herringbone gear counteracts its own thrust, introducing no thrust forces to be taken care of in the gear mounting. It would appear, therefore, that the only practical type of gearing is the double helical. This is not the case, however, because the problem must be considered in its entirety and often the designer has good reasons for using the single helical gear so as to give the shafts axial freedom to take care of external thrusts or movements outside the two gears themselves. It is often more convenient to take care of these thrusts externally to the gears and allow some axial freedom in doing so.

As an instance to the above, there is the case of a rolling mill drive where several stands are to be driven from tandem gears by a single motor. The various roll stands are usually coupled by rather crude flexible couplings and any or all of these stands may throw considerable end thrusts back to the shafts carrying the gears. Often this thrust would be sufficient to cause severe damage if transmitted through the gears themselves. In the case of a double helical gear acting under heavy thrust, the load may frequently be many times the transmitted load due to the axial thrust operating to push one helix against the other, causing contact on the front face on one side and on the back face on the other, the transmitted load in this case being the difference between the loads. Occasionally the herringbone gear will set up axial vibration under these conditions which has been known to cause rapid destruction of the gears. Single spiral gears under these conditions have stood up perfectly, if proper provision has been made to take the thrust in the bearings.

There are three types of herringbone gears in common use. The first is the end milled gear, as made by Citroen in France. This gear suffers from the disadvantage that it must be cut with a form cutter and is not generated. The form cutter loses its shape with use and great care must be exercised in the grinding and in using the cutter to obtain a perfect gear. This type also has the disadvantage that at the apex contact between the two gears is lost, due to the difference in curvature of the surfaces of the teeth in changing from one helix to the other.

Fig. 4—Single Helical Ring Gear for Suction Roll Drive.

A more common type of herringbone cut on a hobbing machine is the Wuest gear. This gear is cut by hobs working at opposite angles and usually on opposite sides. This produces a gear which, on account of the necessary clearance between the hobs at the centre, has a gap in the middle, this gap ranging from 1 to 2½ inches or more, depending on the pitch. This type of herringbone was the first type for which generating machinery was built and came into general use about 1905.

The third type of herringbone gear is the continuous tooth with a closed apex, the two helices meeting in a plane which leaves the corners of the teeth sharp. This gear is the more modern type of generated herringbone and has the advantage of a greater effective face width and a certain amount of buttressing of the teeth in the middle, due to the angle at which the helices meet. It can be generated on several machines of modern manufacture and be cut with great accuracy.

The foregoing mentions several different types of gear cutting systems and some of the advantages and disadvantages of each system will be mentioned. End milling will not be again referred to because this type of gear is not generated and is being abandoned where more accurate systems are available. It is still used, however, on some pitches which are too large to be cut by ordinary generating machines.

The first system used for generating gears was the hobbing system. This system uses a hob with straight sided teeth to cut the involute curve, and is equivalent to generating an involute with a rack. It produces a high grade gear. The proponents of the hobbing machine point to the fact that the indexing on their machine takes place continuously and that the backlash in the indexing mechanism has very little effect on the accuracy of the gear. This undoubtedly is true but the hobbing system suffers from a few disabilities. The circular pitch of the gears can not be so readily controlled. The hob has a fixed pitch and whenever the helix angle is changed by shifting the hob to a different angle relative to the axis of the gear, the pitch of the gear is also changed. In cutting high helix angles, this is a considerable disadvantage, as is also the fact that with the higher helix angles the cutting action of the hob becomes imperfect, due to the teeth of the hob travelling in the same direction as the surface of the gear. There is therefore a limit in hobbing to the useful helix angles which can be obtained. The hobbing process is not as adaptable as some of the other gear generating systems to changes in centres which are often very useful in obtaining the exact ratio desired.

The other system is the shaping or planing system in which the action of the cutter is reciprocating. This system uses two different types of cutters, one of which is roughly in the shape of a rack and the other in the shape of a pinion. The first mentioned type of machine suffers from some of the disabilities of the hobbing process in that the amount the gear can be cut differing from standard centres to obtain adjustment in the ratio is quite limited. It, however, has the advantage of cheap cutters and will generate a satisfactory gear using normal centres and helix angles. The type of machine using a pinion-shaped cutter has the great advantage that gears can be cut of a wide range of pressure angles with the same cutter. The four small gears in Fig. 1 were cut with this type of cutter. This latitude of cutting is not possible with the rack type of cutter. This feature in design is extremely useful and makes possible gears of a wide range of strengths and adaptability from the same machine with the same cutters.

A word should be said at this point as to the various helix angles employed. The very common helix angle of

Fig. 5—Generating Double Helical Gear 20-Tooth No. 2½ D.P. 18-inch face in Sykes machine.

22½ degrees was principally used due to its usefulness on the hobbing machine as producing a gear with a normal diametral pitch with the design of hob then in use. If the problem of the thrust developed by the helix angle is neglected, which can be done with the herringbone gear, the highest helix angle makes the smoothest running gear. There are cutting difficulties, however, in using a helix angle of much more than 30 degrees because the actual pressure angle at which the teeth contact changes with the helix angle without changing the contact pressure in the plane of rotation. For a practical purpose, 30 degrees appears to be the one most generally used and is a good compromise between the wide helix angle for smooth operation and the smaller helix angle for ease of cutting. This angle of 30 degrees has been adopted by several larger manufacturers of gears as a standard and is coming into still more general use. In the case of single spiral gears one large manufacturer has adopted a helix angle of 7½ degrees, claiming that at this angle the axial thrust is negligible. However, this does not give as good a tooth action as a wider angle and for small gears a compromise is often adopted of 15 degrees. There are many considerations when deciding on the helix angle for any particular installation.

Materials

Cast iron and semi steel is still used to a large extent for gearing carrying relatively light loads. In recent years alloy irons have been developed and have been found serviceable in some gearing installations to replace steel castings. It is possible to produce an alloy iron having a tensile strength equal to mild steel, a Brinell hardness of 300 to 350, and yet which can be cut at ordinary cutting speeds and which finishes to a high finish. This is an excellent iron for many types of gearing installations.

Cast iron has one advantage in gearing over steel which has not been sufficiently exploited. The modulus of elasticity of iron is about half that for steel. This means that under the same load the teeth on an iron gear will deflect twice as much as the teeth on a steel gear. This becomes of great importance when dynamic forces are considered, which are mainly due to inaccuracies in cutting of the gear teeth, and which must be taken up by the gear tooth deflection because, at ordinary speeds, the inertia forces of the interconnected loads are so high that practically speaking the gear tooth must deflect the amount of its own inaccuracy. For this reason iron gearing will stand up longer than steel under certain conditions.

However, where care is taken in the manufacture of the gear and the teeth are generated with a high degree of accuracy, the use of steel becomes imperative to obtain the maximum load carrying capacity of the gear teeth. It is quite common to use .40 to .50 carbon forged steel in the pinion and somewhat lower carbon cast steel for the gear. It is a bad practice to run wheels of the same grade together and many failures have occurred for this reason, the failure always taking place in the pinion.

In recent years there has been a tendency to develop higher load carrying capacities in gearing by the use of alloy steels; a useful combination being an S.A.E. 3140 nickel chrome steel in the pinion, heat treated to the hardest condition that can be cut on the gear generating machine, running with a cast steel of approximately .40 carbon content and using a small amount of manganese in the steel casting. This combination is common and produces a pair of gears of about the highest load carrying capacity which it is possible to get unless the gears are hardened after they are cut. This type of gearing is called the heat treated gearing.

Several systems of hardening are in vogue, case hardening being probably the most used and an oil or water hardened high alloy being a close second. Both these systems produce a hard, tough gear but one which suffers from a certain amount of distortion in the hardening. This distortion can be quite serious in large gears.

Quench hardening of high carbon or alloy steels suffers from the same disadvantage. In helical gears there is a tendency for the helix angle to change in hardening due to the tension developed in the gear teeth themselves twisting the blank while in a plastic state. It is a common procedure for automobile manufacturers to generate their gear blanks of a modified helix angle which, when it is distorted in the hardening operation, produces the required helix angle to mesh with the other gears in the gear set. This, of course, has to be done by trial and error and is only practical as in the case of automobile gears where a large number are to be made from one design and one specification.

It can be seen, therefore, that the hardened gear is not the cure-all for gear troubles. It is extremely useful in the case of such gears as can be produced in quantities or for some types of speed reducers which are produced in sufficient quantities to make the correction of the hardening troubles feasible. A great deal can be done in this connection with tooth form grinding and lapping and various systems of lapping and grinding are being used in gear manufacturers plants to correct tooth distortion of this kind.

Fig. 6—Torch Hardening Machine.

A hardening system has recently been developed which for certain classes of work has none of the disadvantages mentioned above. This is the torch or flame hardening process, where the surfaces of the teeth themselves are hardened but the main body of the gear and even the core of the teeth are not affected. With this type of hardening, distortion can be held to a minimum, and it is doubtful if any distortion at all is present. It is possible to get a hardness with the torch hardening process utilizing suitable steels of 600 Brinell, which is somewhat higher than the generally considered useful maximum hardness. The problem in tooth hardening of gears is not, as has been generally supposed, to obtain the hardest possible surface. The failure of a gear usually takes place from fatigue below the actual surface of the tooth. This is due to the rolling action of one tooth on the other and results in pitting of the surface of the teeth. This has been investigated from a theoretical standpoint and has proved to be due to fatigue in shear of the material itself below the surface of the teeth. It is well known that the hardest materials are not those possessing the highest fatigue values and, as in this case fatigue strength is of more value than actual hardness, it is coming to be recognized by gear specialists that a hardness for the individual steel above the maximum fatigue value is useless and is actually detrimental.

Professor Buckingham in his tests on gears under running conditions at the Massachusetts Institute of

Technology has reported that while his test results are incomplete, he finds that gears hardened to the extreme, such as nitrided gears, have a lower load carrying capacity than gears hardened by a process which gives a lower Brinell value but more toughness.

Load Capacity

Until a few years ago the most common formula used in determining the horsepower carrying capacity of a pair of gears was the Lewis formula, which was developed to determine the strength of the gear teeth. This formula has been abandoned, however, for purposes of determining horsepower, as the strength of the teeth usually has little to do with the failure of the gear. Formulae have been developed based on a wear life only and neglecting the tooth strength. Tooth strength will always be a factor, however, and the Lewis formula is still used in checking the strength of the teeth where conditions of abnormal shock or heavy momentary loads have to be encountered.

In considering the wear life of gears, one must first know the actual loading. A valuable contribution on the actual loading taking place between the teeth of a pair of gears has been published by a Committee of the American Society of Mechanical Engineers and is based on a series of tests extending over a period of five years on actual pairs of gears run to destruction. From the results of these tests the committee has developed a formula from which can be estimated the actual dynamic loading which a pair of gears is capable of transmitting. Tests have been run on spur gears exclusively and the gear industry is awaiting with much interest the results on further tests on the same machines utilizing helical gears.

Dynamic loading is always present in the case of spur gears but it is generally considered that the use of helical gearing reduces the dynamic forces to such an extent that they can be neglected. No accurate data is available, however, to support this contention and the dynamic loads to be met with helical gearing are still indeterminate.

An interesting paper was read by Mr. W. P. Schmitter before the A.G.M.A. Annual Convention* last spring on the theoretical considerations of contact between the surface of the teeth of a pair of helical gears entitled "Helical and Herringbone Speed Reducer Ratings." This is a step forward in the available data on the subject, but the formulae developed are rather cumbersome to utilize in everyday work. Formulae have been developed, however, from actual known cases of success and failure extending over many years and which are serviceable for every day use. Practically all manufacturers of herringbone and helical gearing use these simple formulae. The following is a formula very generally used for the horsepower capacity of helical gearing.

H.P. Formulae

$$H.P. = \frac{D^2 \times W \times N \times B \times S \times C}{1260} \quad \text{or} \quad \frac{P}{WD} = 100 \times B \times S \times C$$

D = Diam. of pinion in inches.
W = Face width in inches.
N = R.P.M. of Pinion.
P = Total pitch line load.
B = Velocity factor.
S = Material factor.
C = Service factor.

Velocity Factor

Pitch Line Speed	"B"	Pitch Line Speed	"B"
0 Feet per minute	1.8	2000 Feet per minute	.9
200 " " "	1.5	3000 " " "	.85
500 " " "	1.25	4000 " " "	.8
1000 " " "	1.15	8000 " " "	.7

*American Gear Manufacturers Assn., Meeting May 3-5, 1934.

Material Factor

Pinion Steel	Gear Steel	"S"
.40 Carbon forged steel	.30 Carbon cast steel	1
.50 " forged 200 BHN.	.40 " " "	1.2
SAE. 3140 " 225 "	.50 " " "	1.4
Alloy steel hardened 500 BHN.	.50-C Med. mang. cast steel	2
" " " 500 "	.50-C Steel hardened 400 BHN.	2.5

Service Factor

Character of Loads	"C" 24-hr. Continuous	10-hr. Continuous	1-5 hr. Inter.	Occas. short runs
Heavy duty starting conditions full motor overloads and shock................	.45	.6	.8	1
Heavy starting loads Average run motor ratings...	.6	.8	1	1.25
Medium starting loads Average runs ¾ motor rating	.8	1	1.25	1.5
Light starting loads Average runs ½ motor rating	1	1.25	1.5	2

Spur gear rating....... .8
Open gear rating...... .8
Speed increasers.......Special

In the development of this formula it has been assumed that the horsepower capacity of a pinion is directly proportional to the diameter and face width. While this may not be strictly true in all cases, it is approximately true in the great majority of gear designs and has good theoretical backing to recommend it. The modification factors for velocity service and material are important. The velocity factor is introduced to take care of dynamic loads which are accentuated by higher speeds. The service factor is introduced to take care of applied loads exterior to the gear and, to a certain extent, of the endurance capacity of the gears. The material factor is self-explanatory. The service factor is the most important one to be considered in the use of this formula. The reason for this is that the other factors such as velocity, material, etc. can generally be determined by the gear designer but he must use his judgment to estimate the service the gear has to meet in use. The practical horsepower capacity of a gear set may vary over a range of 500 per cent, from extremely severe service conditions such as a rolling mill drive to light intermittent duty such as the operating gear of a valve. To rate a gear set for a given horsepower at a stated ratio and speed and neglect the service factor, is just as foolish as to say that an athlete who can run 100 yards in ten seconds can keep up the same rate of speed all day. In either case fatigue is neglected which, while it would not occur as quickly in a gear set as in the case of the athlete, will be just as certain. It is interesting to note that automobile gearing, which is probably the most highly developed gearing in general use, is designed to be adequate without being unnecessarily large. It is rarely called upon to transmit full engine power for more than a few seconds at a time and in fact the gearing in common use on trucks has a life of only about five hours at full engine power with low gear engaged yet failures in normal service are exceedingly rare. It would be uneconomical, in view of the low percentage of failures, to build such gears with a full load life expectancy of even a week on continuous running because this condition would never occur.

The service factor in the design of gearing is of prime importance and the factors shown on the attached chart can be used as a guide but, however, could be extended or reduced at the discretion of the designer within certain limits. Those shown are for the ordinary run of commercial gearing but for high speeds, and particularly for speed increasers, the factor will generally be below the .45 shown as the minimum. For intermittent duty, or where the life is not important, the factor can be extended beyond the value of 2 shown.

For a quick check on horsepower capacity of gearing, the simplest formulae is the following:

$$\frac{P}{WD} = 100 \times B \times S \times C$$

This formula means that the total pitch line load divided by the face width and the diameter of the pinion is equal to 100 times the various factors shown. The value P/WD should be not more than 50 for high speed gears, increasers, and heavily loaded drives; 100 for the ordinary type of commercial speed reducers and all the way up to 1500 for such gears as the drive gears for the propellers of an airplane which are made of extremely good material, hardened to the extreme, and lapped to the maximum accuracy possible, and where the life, in any case, is limited to a certain number of hours of engine operation.

Any formula or expression is proposed for guidance only, and to assure that the recommendations of the designing engineer will be consistent and conservative. The specification covering the gear set must be tempered by his experience, his sense of proportion and his good judgment, just as with the design of any other piece of equipment.

An attempt has been made to put, in their simplest form, the two most useful formulae used today in designing gears. Many other considerations, however, have to be borne in mind. These formulae are generally based on the assumption that the ratio would be about 5:1, and it will be found that for low ratios such as a 1:1 drive, considerable modification would have to be made because the assumption that the horsepower capacity is proportionate to the diameter of the pinion would obviously not hold good in this case. It is usual to assume that spur gears have approximately 80 per cent of the value shown on the above formulae which have particular reference to herringbone and helical gears.

Consideration must also be given to lubrication and these formulae should not be used for anything but gears operating under perfect conditions. For exposed gears a considerable modification would have to be made.

Gear Mounting

The mounting of the gearing is another important subject as for best results gearing must always be mounted on fixed centres and by means of bearings and shafts which will not deflect and throw the gears out of line under load. It will be obvious that if one of the shafts deflects, the tooth contact will be made on the corners of the teeth and the surface in contact will be rapidly destroyed from overloading. The highest development of gearing utilizes the enclosed gear cases with high grade sleeve or roller bearings mounted on the shafts as close as possible to the gears and with adequate lubrication for the teeth.

The use of roller bearings is becoming general in gear mountings even in the case of large rolling mill drives on account of the benefits from such mounting in that the gears are always held to exact fixed centres and that the axes of rotation of the two gears is always held parallel. Roller bearings are an extremely useful type of bearing and the writer knows of only one application where a sleeve bearing would be preferable, namely, in extremely high speed gearing where the noise due to a roller bearing mounting transmitting the gear vibration to the case becomes extremely annoying. Theoretically it is possible to cut a pair of gears which will operate noiselessly but practically speaking all commercial cut gears will make a certain amount of noise in operation. This noise is accentuated by high speed operation and where roller bearings, with their metal to metal contact, are used under these conditions, the whole set, although it may be a perfectly satisfactory machine from a life point of view, is likely to be extremely noisy. For this reason it is usual to use high grade self-aligning sleeve bearings for these conditions.

Lubrication

The subject of lubrication is one that can be treated in several different ways. The object, of course, is to maintain an oil film between the teeth of the gear at all times so that actual metal to metal contact does not take place. The design of the teeth has some bearing on the ability of the oil to lubricate the gears properly.

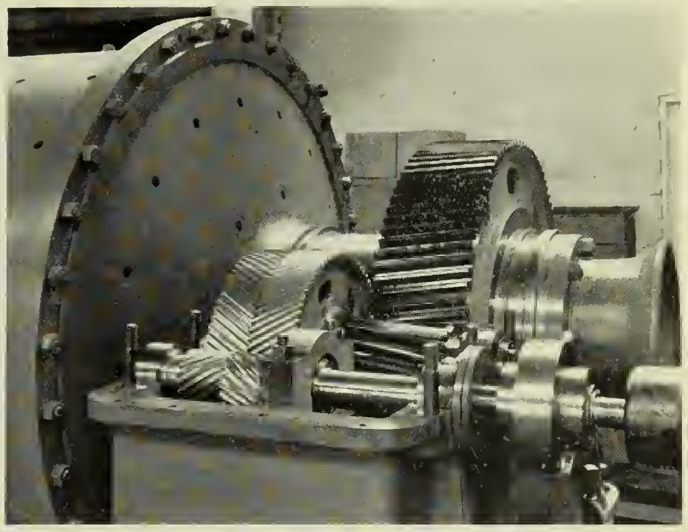

Fig. 7—Drive Gears for a 6-foot by 5-foot Ball Mill.

As mentioned previously one of the reasons for the use of the modified addendum for enclosed gearing is to increase the contact on the arc of recession, that is, where the teeth are drawing apart, and to decrease the contact on entrance. The reason for this is that where the teeth are entering, the tip of one tooth has a tendency to scrape off the oil from the flank of the mating tooth. This occurs up to the point where the pitch point is crossed. After the pitch point, the direction of slide of one tooth on the other is reversed and the slide takes place with more of a wiping action, which has a tendency to retain the oil between the surfaces rather than scrape it away. For this reason the teeth of the pinion are usually lengthened and the teeth of the gear shortened, or, as it may be termed, the addendum ratio of pinion to gear is increased.

If you will observe the Vickers Bostock gear you will note that the contact is all on the recession side of the pitch point, the lubrication is very efficient and this accounts to a large extent for the excellent operating characteristics of these gears. For this reason also it is usual in the case of a stepped up ratio, or an increaser, to reverse the ratio of addendums, making the addendum of the gear greater than the addendum of the pinion, which has the effect of increasing the arc of recession again at the expense of the arc of entrance.

Many different types of oils are utilized in the lubrication of gears. In general it can be said that the heaviest oil which can be carried into the tooth mesh without excessive heating from churning will be the best for the lubrication of the gears. Some special oils have been developed having a greater stickiness than normal oils of the same body for gear lubrication and these are undoubtedly extremely useful. In the past few years another grade of oil has been developed called the E.P. (extreme pressure) oil. This oil is usually combined with some compound which produces a very hard coating on the surface of the teeth themselves due to a combination of the oil with the steel of the gear. This oil has been extremely useful and was developed to increase the load carrying capacity of automobile gears, where the whole tendency seems to be to make the engines of more and more power while keeping the gears of approximately the same size for purposes of road clearance. To date, however, this oil has not been used to any great extent in commercial gearing. It has no value whatever in increasing the resistance of the pair of gears to pitting from fatigue, and as this type of failure is usually the first sign of failure from overloading, the use of the E.P. oils, with an increase in load carrying capacity, does not seem to be advisable, at least until more is known about the subject.

In lubricating a speed reducer it is usually necessary to use an oil which will also be suitable for the bearings. In the case of roller bearings this presents no difficulty because any oil which is satisfactory for gearing will be satisfactory for the roller bearings, provided they are fed with the required amount regularly. In the case of plain bearing speed reducers, however, the heavy oil suitable for the gears is not always suitable for the bearings, which might be ring or collar oiled, and it becomes necessary to provide a gear case with two different oiling systems which must be kept apart to prevent the contamination of one oil by the other. This presents considerable difficulty in the use of such bearings for heavy duty gearing. As to lubricating systems, it is generally considered that up to a pitch line speed of 2,500 or 3,000 feet, splash lubrication is perfectly satisfactory. Above this range of speed, spray lubrication becomes necessary, involving the use of an oil pump with sprays to feed the mesh of the gears with an adequate supply of lubricant. Generally speaking, for the higher speeds, a cooler is also essential because the heat radiating capacity for all gear boxes of extremely high speeds will be inadequate to dissipate the heat generated. In utilizing splash lubrication, it is advisable not to dip the gears too far into the oil. Cases have occurred where a gear case was running hot and the user kept adding oil with the result that the gear case ran hotter, due to churning of the oil. No definite rules can be laid down as to the amount the gears should dip into the oil because this will vary considerably with the speed and with the body of the oil. It is only necessary to dip the gear sufficiently to carry an adequate supply of oil into the mesh. Anything more than this results in a useless waste of power in churning the oil.

In considering the advisability of cooling in speed reducers, it is interesting to note that the modern gearing utilizing herringbones or spiral types of gears cut on a generating system with extreme accuracy and adequate lubrication operates at efficiencies of about 98 per cent. Cases have been known on actual test where gears of this type have developed an efficiency of over 99 per cent. The amount of heat to be dissipated is, of course, proportional to the drop in efficiency in the gear set, and this must be dissipated into the surrounding air by the surface of the gear case.

Conclusion

The statements made in the foregoing are what are generally conceded to be the best conclusions that can be drawn from empirical and theoretical data available. There is no doubt, however, that with the furthering of the knowledge on gearing, and with more tests, considerable modification will have to be made in the various conclusions drawn. In any case there is no question but that modern gearing is an extremely efficient and useful mechanism. The various uses to which it is being put are ever being extended and engineers in general are coming to have more confidence in this type of mechanism.

DISCUSSION

C. D. Bailey, A.M.E.I.C.[1]

This paper is of great interest, because of its broadly informative character and the intensive development proceeding in gear engineering.

Our present conception of gear teeth is that of an elastic mechanism, sustaining and transmitting loads of orders and at speeds which permit of only the most refined geometric forms.

In the area of the overlap of the pinion on the gear, which may be called the mesh, there is a balanced system of forces caused by the total dynamic load. This dynamic load has two components:—

(*a*) The useful transmitted load;
(*b*) The increment load.

This increment load is the sum of the effect of the vibrations system of the mechanism and the resistance of the inertia forces to changes of velocity induced by errors of the gear tooth forms.

It is proposed to outline the development of a gear system wherein this increment load has been reduced by greater potential accuracy of form, and whose transmission capacity has been added to by a reasoned selection of that portion of the involute curve which forms the working profile.

Description of System

A review of conditions existing five years ago revealed that while the standard systems had excellent properties in certain ranges, the effects and appearance of undercut teeth were objectionable; that gears were noisy and that they showed excessive wear.

A decision to improve matters determined that a replacing system would include shapely tooth forms of

[1]Dominion Bridge Company Limited, Lachine, Que.

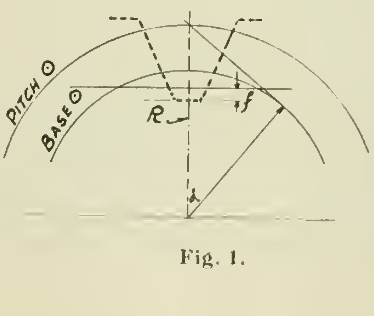

Fig. 1.

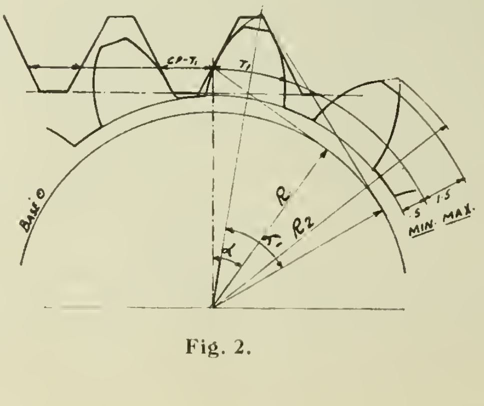

Fig. 2.

balanced strength, with favourable rolling and sliding action, and that the tooth form would be modified to preclude interference.

The principle of universal interchangeability was abandoned. Centre distances proportional to the number of teeth in a pair were retained.

Tooth forms would be involute and would all be generated from the same basic rack. The number of teeth in the smallest pair would be 42, infrequent smaller pairs being embraced by a subsequent extension of the system. The smallest pinion would have 10 teeth and the maximum ratio of addendum to dedendum would be 3 to 1.

The operating pressure angle of 20 degrees, constant by virtue of standard centre distances, was selected when comparative analysis indicated its greater possibilities.

The critical 10-tooth pinion for the smallest pair of 42 teeth was then designed by including the most suitable portion of the involute between the limits of undercut radius $R \cos^2 \alpha - f$ and the radius at which the tooth became pointed $R^2 = \dfrac{R \cos \alpha^2}{\cos \alpha_1}$. This was obtained by means of an outward radial shift of tooth profile on the pinion and a corresponding inward radial shift on the gear.

The 10-tooth pinion was then meshed with the next larger gear—33 teeth—then 34 teeth, and so on, and as the gear increased the practicability of increased shift was utilized until the 10-tooth pinion meshed with a 35-tooth gear when the 3 to 1 maximum ratio of addendum to dedendum was reached after which this maximum shift was constant on all succeedingly larger gears. The same method was followed on the 11-, 12-. 13,- 14-, and 15-tooth pinions, meshing them with first their smallest gear, 31 tooth with the 11-tooth pinion, 30 on the 12-tooth, and so on, then with gradually increasing gears until the maximum shift was reached then continuing this shift unaltered for all larger gears. When the 16-tooth pinion meshed with the 40-tooth gear this progressive correction was arrested somewhat before the maximum correction was reached; because of extremely favourable contact conditions. This followed with the other larger pinions—17, 18, 19, 20 and 21 teeth. The 21-tooth wheels were the smallest equal wheels by the minimum limit of 42 and were identical by symmetry.

The corrections or shifts of profile were then averaged using Buckingham's method of arbitary increments, twenty-five steps of .02 giving the maximum correction and the correction of any pair being .02 $(N - n)$, or if the gear had more than 40 teeth, .02 $(40 - n)$, where N = number of teeth in gear and n = number of teeth in pinion.

Quality of Contact

During these selections of profile certain criteria of quality were established to govern judgment and to maintain it consistently.

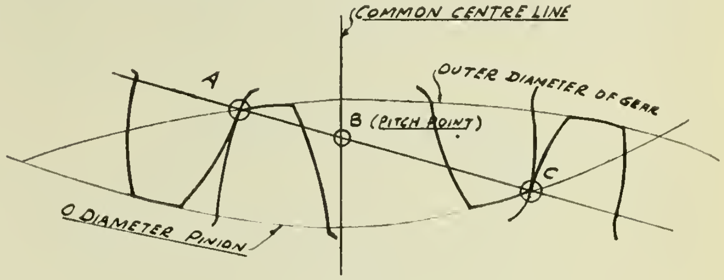

Fig. 4.

They consisted of:

(*a*) Duration of contact.
(*b*) Sliding and rolling properties.
(*c*) Minimum radius of curvature.
(*d*) Strength of form.

Duration of Contact

The common tangent to the base circles of the pinion and the gear is the locus of the point of contact. Theoretically, contact begins at "*A*" and ends at "*C*." If we take the line *AC* and superimpose it on either of the base circles the arc it will cover will be the arc of contact and its length divided by the normal pitch will be the duration of contact expressed in tooth intervals. The arc *AB* will be the arc of approach and the arc *BC* will be the arc of recess.

The value of long duration of contact lies in the condition of distribution of load among a greater number of teeth, in the reduction of load imposed near the root and near the tips of the teeth, and in the consequent smooth-

Gear Teeth	Pinion Teeth																													
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
21												.00																		
22											.04	.02	.00																	
23										.08	.06	.04	.02	.00																
24									.12	.10	.08	.06	.04	.02	.00															
25								.16	.14	.12	.10	.08	.06	.04	.02	.00														
26							.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00													
27						.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00												
28					.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00											
29				.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00										
30			.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00									
31		.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	16	14	.12	.10	.08	.06	.04	.02	.00								
32	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00							
33	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00						
34	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00					
35	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00				
36	.50	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	08	06	04	02	.00			
37	.50	.50	.50	.48	.46	44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00		
38	.50	.50	.50	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00	
39	.50	.50	.50	.50	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02	.00
40	.50	.50	.50	.50	.50	.50	.48	.46	.44	.42	.40	.38	.36	.34	32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	.06	.04	.02
41	.50	.50	.50	.50	.50	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	14	.12	.10	.08	.06	.04	.02
42	.50	.50	.50	.50	.50	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22	.20	.18	.16	.14	.12	.10	.08	06	.04	.02
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.

Fig. 3—Table of Shifts "*C*" for Gear and Pinion for No. 1 D.P.
Outside diameter of Gear = Pitch diameter + 2.00 inches − 2 *C*.
" " of Pinion = " " + 2.00 inches + 2 *C*.

ness of transfer of load. For any kind of transmission of power, the duration of contact must exceed 1.0 tooth intervals; should exceed 1.35 tooth intervals, and in the system being described is never less than 1.44 tooth intervals.

From Baud and Peterson 1929:—

When D = Duration of contact of 1 − 2 tooth intervals.

One pair of teeth sustain load $\left(\frac{2}{D} - 1\right)$ of time.

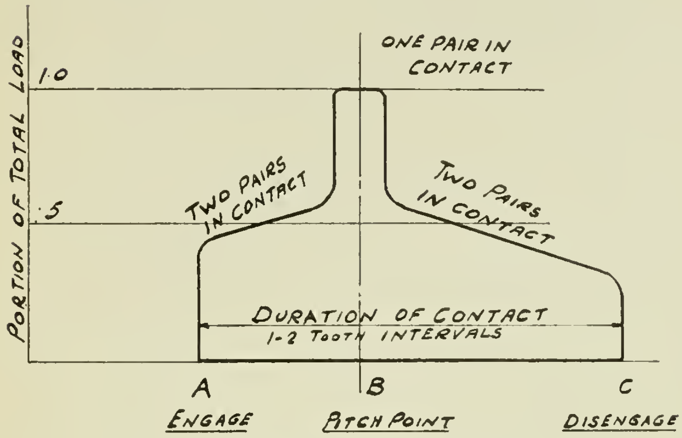

Fig. 5—Typical Variations in Load on Contact Point as it Proceeds Through Mesh.

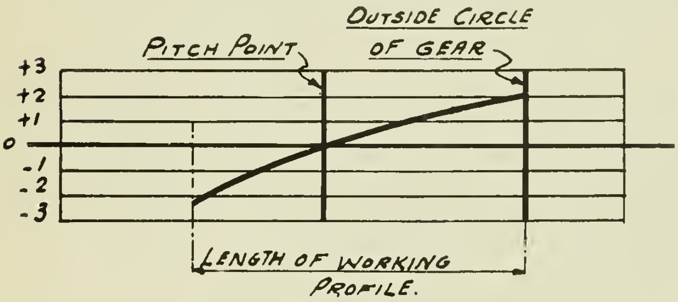

Fig. 6—Graph of Slide.

Two pairs of teeth sustain load $\left(2 - \frac{2}{D}\right)$ of time.

When D = Duration of contact 2 − 3 tooth intervals.

Two pairs of teeth sustain load $2\left(\frac{3}{D} - 1\right)$ of time.

Three pairs of teeth sustain load $3\left(1 - \frac{2}{D}\right)$ of time.

Sliding and Rolling

In involute tooth action when engagement takes place near the pinion base circle, a relatively long arc of the gear tooth contour slides over a very short arc of contour of the pinion tooth. When contact has progressed to the pitch point the radii of the arcs in contact are proportional to the gear ratio and a purely rolling action is simulated. As contact proceeds into the arc of recess the increasingly greater arcs of contour of the pinion tooth slide over the decreasing arcs of the gear tooth so that the direction of sliding changes and its amount increases to the point of disengagement.

The specific sliding is the amount of sliding per unit length of the arc of profile on which the sliding occurs and, while unimportant by itself, it is essential that its change along the tooth profile be gradual. Abrupt change in the graph of the value shows sensitivity of form and may indicate difficulty of lubrication of the tooth form in service.

Minimum Radius of Curvature

This important length is the least radius of the involute of any working profile in the mesh. When engagement takes place near the base circle it is short and rapidly changing, that is, sensitive. This sensitivity is expressed in violent change in sliding and is perhaps productive of the major errors in the tooth form, owing to the inability of the

Fig. 7—Stress Concentrations at Fillets.

Pair	Elements	System			
		20 deg. New Std.	20 deg. Std.	20 deg. Stub.	14½ deg. Std.
12-30	Contact	1.48	1.234	1.237	0.807
	Spec. Sliding Pinion	−5.8 0.8	−4.3 0.707	−15.68 0.64	
	Spec. Sliding Gear	0.85 −3.95	0.81 −2.42	0.94 −1.81	
	Min. Rad. 1 D.P.	0.40″	0 5035″	0.1682″	
	Beam Strength	0.097 0.098	0.078 0.114	0.099 0.139	
15-27	Contact	1.5	1.539	1.287	1.049
	Spec. Sliding Pinion	−4.25 0.78	−17.8 0.716	−5.27 0.645	−2.15 0.65
	Spec. Sliding Gear	0.81 −3.47	0.945 −2.52	0.841 −1.82	0.68 −1.87
	Min Rad. 1 D.P.	0.69	0.2064	0.58	1.2259
	Beam Strength	0.101 0.099	0 092 0.111	0.111 0.136	0.078 0.099
21-40	Contact	1.56	1.65	1.35	1.508
	Spec. Sliding Pinion	−1.15 0.70	−4.25 0.60	−2.14 0.53	−3.57 0.78
	Spec. Sliding Gear	0.54 −2.35	0.844 −1.49	0.68 −1.14	0.782 −3.53
	Min. Rad. 1 D.P.	2.06	0.95	1.5014	0.7887
	Beam Strength	0.123 0.108	0.104 0.122	0.127 0.145	0.092 0.106

Fig. 8.

hob, or cutter, to faithfully reproduce the rapidly varying curvature.

The outward radial shifts of pinion tooth profile postulate an increase in this radius and, therefore, an increase in capacity of the profile to sustain load:—

(*a*) at a point where it is usually most unfitted to take it;
(*b*) at a point where high stress is exceedingly dangerous because of the proximity of the stress concentrations at the fillet of the tooth root;
(*c*) at a point where, because of (*a*) or (*b*), or both, wear and destruction of the tooth form is most evident and troublesome on standard tooth forms.

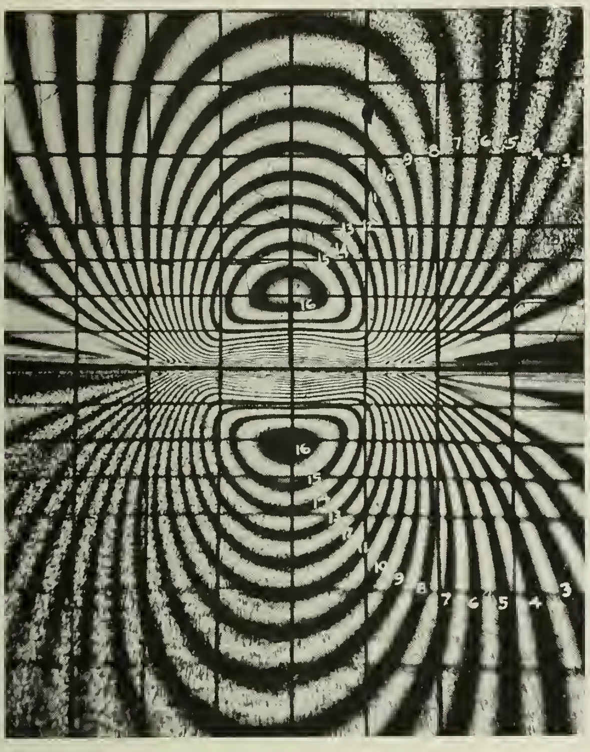

Fig. 9—Stress Distribution in Gear Teeth at Contact Points.

Lewis Factor Y

This is a tooth form factor used in the Lewis formula $W = SPFY$ where S is the stress from primary bending considering the load W applied at the tip of a tooth of circular pitch P. While the formula apparently takes no account of the relieving influence of long contact (Fig. 5) when less than half the load will be applied at the tip and when the full load is only sustained near the pitch line, this is approximately balanced by the existence of stress concentrations at the root fillet (Fig. 7). The figured stress is probably an inclusive approximation of the maximum stress from primary bending in well designed teeth and all gears (especially those whose surfaces have been hardened to resist wear and, therefore, to sustain greater unit loading) must be designed to resist it.

Comparison of Results of Gear Systems

The shifts of tooth profile have resulted in uniformly high qualities of all properties. In Fig. 8 three ratios from the system being described (which is here named the 20 degrees New Standard), are compared with ratios from other important gear systems.

In the 12/30 tooth ratios the 14½-degree standard system has no continuity of contact while the 20-degree stub and the 20-degree standard is apparently good, but this is due to an extensive undercut being present on the tooth which is reflected in the contact, the minimum radius, and in the weakness of the pinion.

In the 15/27-tooth ratio only the 20-degree new standard and the 20-degree standard are suitable for inclusion in a power drive or any responsibility, with the sliding well balanced on both and of moderate magnitude. The minimum radius of 20-degree new standard is three times that of the 20-degree standard.

In the 21/40-tooth ratio the contact is of reasonable duration on all systems except the 20-degree stub. The better sliding, greater minimum radius, and balanced strength of the 20-degree new standard system are evident.

The excellent sliding characteristics of the 20-degree new standard system, which is, of course, a long and short addendum system, are at variance with the views expressed by the author in that section of his paper dealing with tooth forms and are in part responsible for the excellent functioning of these gear teeth.

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Professional Technical Training

A study of the present membership list of any professional engineering organization, as compared with a list of twenty years ago, will make it evident that engineers as a class are becoming employees rather than employers. The proportion of members of The Engineering Institute, for example, who are in private practice as consulting engineers has dropped steadily, while more and more of our members have become engaged in various salaried capacities in the field of industry, in engineering, supervisory or executive positions; many are concerned with sales or service activities in connection with engineering equipment or products.

To devise educational courses which will prepare for the more responsible positions in such a diversity of occupations is a formidable task; in fact the field of engineering training is full of experiments, the interpretation of whose results gives rise to constant debate. There are, however, certain broad questions which claim attention. To what extent are the higher supervisory and executive positions in the field of industry, including in this term service and construction as well as manufacturing, filled by university graduates in engineering as compared with men trained along other lines? What provision is made for the benefit of technicians, superintendents and foremen in the form of technical training of a less advanced kind than that given in the universities? Are the needs for vocational or apprentice training being met with a view to an adequate supply of skilled craftsmen? What chance of advancement in status is there for a man who has not been able to find the time or money necessary for a college course, and has been trained along more specialized, but possibly less theoretical lines? Such queries as these give food for thought. It must be noted that at the present day the demands on the intelligence and education of men who are leaders in the workshop or on the construction job, are continually increasing. A foreman, besides supervising the work in his department, may have to pronounce on the response of new materials to new methods, or deal with questions of rate setting, economics of handling materials, or the working of cost systems. Modern mass production has called into existence an army of specialists who deal with the design and construction of tools and jigs, or equipment for special processes of treatment or manufacture. In fact, the workshop is, to-day, offering a far wider opening for technically trained men than has ever existed before.

The types of technical training now available in Britain and North America for those who are to be engaged in the engineering industries may be broadly classified as, post-graduate work at the university in preparation for special work or research; the normal four-year engineering courses at schools of university rank; the shorter and less advanced courses of training offered by technical institutes; and the courses given at vocational or apprentice schools. The two latter naturally have closer relationships with specific industries than is possible in the case of university courses. It is interesting to note that in the United States, technical institutes or schools are maintained by a number of the larger industrial companies for the purpose of training new employees.

The General Motors Institute of Technology at Flint, Mich., is a good example of this type of school. Its object, as the president of General Motors Corporation puts it, "is to select men with potentialities for broader responsibilities and attempting to train these men for advancement." It provides a two year course in basic subjects such as mathematics, mechanics, machine design, engineering English and shop practice, followed by a further two years in industrial plant or service subjects. Throughout their courses, students receive pay as employees of the company, but a substantial tuition fee is charged. Almost without exception, high school education is required for admission. A recent report states that over ninety per cent of the young men passing through the school remain in the employ of the Corporation. Many technical institute courses of the United States, like those at Flint, are co-operative, the students spending their time partly in the school and partly in the shops.

As regards the demand for educational facilities of this kind, it has been estimated that in the United States, while ample provision for four-year engineering training is provided by the engineering colleges now existing, about one hundred and fifty in number, industry could absorb some forty to fifty thousand technical institute graduates annually, a number substantially in excess of those now available. A recent survey of industrial education in the eastern states gives for the New York area alone a total of some one hundred and twenty thousand supervisory positions in fifty-three thousand companies, employing one and a half million men. Only a small proportion of these concerns offer instructional courses for their employees, but it must not be forgotten that in all the larger industrial centres there are available well developed programmes of evening instruction. Unfortunately it does not seem possible to extend these facilities to less thickly populated areas, and the courses offered by correspondence schools are only a partial substitute for personal teaching and laboratory work.

The situation in Britain has developed along somewhat different lines, and is more systematically arranged. Engineering instruction of university rank is given in all the main centres of population. There is a well organized system of local technical schools, provided with laboratory facilities and giving both day and evening instruction of a more utilitarian type, in many cases with the co-operation of local engineering firms. There are regular standards for entrance requirements and the universities recognize the work done at a number of the larger technical schools, admitting to their degree examinations students from them who have followed certain prescribed courses. In other cases, the local technical institutes' courses are such as to prepare for the Associate Membership examinations of the Institutions of Civil, Mechanical and Electrical Engineers, or for other like examinations which in England are becoming widely recognized as standards of engineering education. In England the support of industry has been given to this work rather by benefactions from industrial leaders than by the establishment of special schools by the industries themselves. The government and local authorities have been able to spend a good deal of public money on technical education with the result that the classes provided are comparatively inexpensive. Further, in many of these schools, by the aid of scholarships, a boy of capacity, even if his means are small, can obtain an excellent training.

In this country we are well provided with engineering schools of university rank, whose excellence is attested by the careers of their graduates. First rate technical schools exist, like those in Toronto, Hamilton, Montreal and elsewhere, but outside of the main centres of population there are not as yet in Canada adequate facilities for the young man who has to work for his living and at the same time desires to fit himself for advancement in industrial life. We have very few scholarships. It would seem that here, as in the United States, as far as engineering education is concerned, the need is not for a larger number of four-year engineering colleges, but for a higher standard of admission and attainment in those that now exist. It is believed that there are many undergraduates in these institutions whose characteristics and bents are such that they would do better in some more utilitarian type of training, and that the efforts of the university staffs would be more effective if the undergraduate standard were raised. On the other hand, better provision should be made for technical school students of exceptional capacity and force of character who wish to proceed to institutions where they can fit themselves for the higher branches of engineering work.

There is at the present time a tendency to lay stress on the possession of a university degree, as in itself constituting a guarantee of professional capacity as an engineer, and as being alone sufficient to differentiate its possessor from the mere technician. A degree from one of our leading engineering schools is no indication of professional experience, but it does confer a definite status not attainable in any other way; such degrees are therefore recognized by The Institute by-laws and by those of the professional associations. It is noteworthy, however, that The Institute's requirements for admission as corporate member do not close the door on those who have not had the advantages of a university course, provided that they can show that they have received an equivalent training by other means. It is for this reason that The Institute's system of examinations has been established. Many of the candidates who take them have had engineering experience of a kind which makes them invaluable in the modern world of industry and when admitted are able to make substantial contributions to The Institute's work in the interchange of professional knowledge. Any scheme of professional organization which fails to provide for the recognition of such men would be open to objection, as bearing hardly on a class whose exclusion from its ranks would be a great loss to the engineering profession.

New Membership List

It is over three years since the last list of members of The Institute was published, and it has been found necessary to issue a new edition this Fall. This list will appear as a separate section of The Engineering Journal.

Information cards have recently been forwarded to the membership of The Institute, requesting the name, present official position and address of each member that this information may be correctly recorded.

The completeness and accuracy of the list will be greatly increased if the members will co-operate fully and return their cards with as little delay as possible.

The Institute Prizes and Medals

The Sir John Kennedy Medal—a gold medal awarded to corporate members of The Institute as a recognition of outstanding merit in the profession or of noteworthy contribution to the science of engineering or to the benefit of The Institute.

Past-Presidents' Prize—a cash donation of the amount of One Hundred Dollars, or the winner may select books or instruments of no more than that value, for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year. The subject of the essays to be submitted for the competition for the prize year July 1st, 1935 to June 30th, 1936, is "The Engineer's Contribution to Transportation."

The Duggan Medal and Prize—a prize of a medal and cash to a combined value of approximately $100.00 open to all members of The Institute to be awarded each year from the proceeds of a donation by Past-President G. H. Duggan, D.Sc., LL.D., M.E.I.C., for the purpose of encouraging the development of the branches of engineering in which he practised. Papers to be eligible for this competition shall deal with such subjects as arise in that sphere of constructional engineering which concerns the use of metals in moulded or fabricated shape for structural or mechanical purposes.

The Gzowski Medal—a gold medal awarded to members of The Institute for the best paper of the medal year, provided such paper shall be adjudged of sufficient merit as a contribution to the literature of the profession of civil engineering, but not otherwise.

The Leonard Medal—a gold medal awarded to members of The Engineering Institute of Canada or of the Canadian Institute of Mining and Metallurgy, for papers on mining subjects presented either to The Institute or to the Canadian Institute of Mining and Metallurgy.

The Plummer Medal—a gold medal open to those who belong to The Institute or to non-members if their papers have been contributed to The Institute and presented at an Institute or Branch meeting. The papers to be on chemical and metallurgical subjects.

Prizes for Students and Juniors—technical books or instruments to the total value of Twenty-Five Dollars. Students and Juniors of The Institute only are eligible to compete.

The H. N. Ruttan Prize—The four western provinces;

The John Galbraith Prize—The province of Ontario;

The Phelps Johnson Prize—Province of Quebec (English);

The Ernest Marceau Prize—Province of Quebec (French);

The Martin Murphy Prize—The Maritime provinces.

Sir John Ambrose Fleming Receives the Kelvin Medal

The Kelvin Medal is awarded triennially as a mark of distinction in engineering work or investigations of a kind with which Lord Kelvin himself was especially identified, the award being made by a committee appointed by the principal engineering societies in Great Britain.

This year, on Tuesday, May 7th, the medal was presented to Sir John Ambrose Fleming, F.R.S., at a meeting held at the Institution of Civil Engineers, the presentation being made by the Postmaster-General. In doing so, Sir Kingsley Wood pointed out that engineers were indebted to Sir Ambrose, not only for his own contributions to research, but also for the inspiration he had given to many generations of students. He was glad to have the opportunity of drawing attention to the great debt which the radio industry owes to Sir Ambrose for the development of the thermionic two-electrode valve.

OBITUARIES

Charles Lang Cantley, A.M.E.I.C.

It is with deep regret that we place on record the death of Charles Lang Cantley, A.M.E.I.C., while bathing at Scarboro Beach, Me., on July 14th, 1935,

Mr. Cantley was born at New Glasgow, N.S., on May 4th, 1884, and received his early education at the New Glasgow Public School and St. Andrews College, Toronto, graduating from McGill University in 1909 with the degree of B.Sc.

Following graduation Mr. Cantley joined the staff of the Nova Scotia Steel and Coal Company, and until 1910 was resident engineer in charge at Wabana Mines Limited, Newfoundland. He was later engineer and assistant underground manager. In 1911 Mr. Cantley was appointed engineer at Sydney Mines, N.S.

On the outbreak of war, Mr. Cantley went overseas as a major in the 13th Royal Highlanders of Canada (Black Watch) but due to his outstanding ability in the metallurgical field coupled with executive ability, he was recalled to Canada to reorganize the munitions department of the Nova Scotia Steel and Coal Company.

After the war Mr. Cantley went to the United States and became engineer with the Mutuelle Solvay of America Inc., in New York. Later, returning to Canada, he became general manager of the Nichols Engineering and Research Corporation of Canada Ltd., in Montreal, and a year ago was appointed president of the Company.

Mr. Cantley joined The Institute as a Student on May 2nd, 1907, and on June 10th, 1911, became an Associate Member.

Alfred O'Meara, M.E.I.C.

Members of The Institute will learn with regret of the death at Victoria, B.C., on July 5th, 1935, of Alfred O'Meara, M.E.I.C.

Mr. O'Meara was born at Stoke Prior, Worcestershire, England, on August 4th, 1858, and received his later education in Cork, Ireland, taking a course in civil engineering at Queens College in 1876-1879. Following this he was until 1880 pupil of a Mr. Law of the Ordnance Survey, Southampton. In 1881 he was on the construction of the Nottingham Melton Mowbray railway, and later received practical instruction in underground work at a tin mine in Cornwall.

In 1883 Mr. O'Meara proceeded to Newfoundland, and was for the next three years in charge of prospecting and developing an auriferous quartz mine on the north east coast. In 1886-1888 he was assistant in charge of location and construction of the Placentia Railroad, and in 1888-1890 Mr. O'Meara was in charge of the city sewerage works of St. John's, Newfoundland. In 1888 he was appointed deputy land surveyor for the Island of Newfoundland and Dependencies. In 1892 Mr. O'Meara went to British Columbia, and was in charge of drainage works for the municipality of Chilliwack until 1894, when he returned to St. John's, Newfoundland, and engaged in private practice. In 1898-1903 Mr. O'Meara was in charge of mining work for the British Columbia Rossland and Slocan Syndicate in the Yukon Territory and Northern British Columbia. Returning to Victoria he practiced engineering in that city until 1905 when he joined the engineering staff of the city, retaining the connection until several years ago when he retired.

Mr. O'Meara joined The Institute as an Associate Member on October 8th, 1908, became a full Member on April 13th, 1912, and was made a Life Member in November 1923.

PERSONALS

B. Russell, M.E.I.C., has been appointed chief engineer for the Water Development Committee under the Rehabilitation Board for the Prairie Provinces, and will be located at Swift Current, Sask.

Edwin J. Beugler, M.E.I.C., consulting engineer, Cheshire, Conn., has been appointed a member of the first board of registration for state engineers and surveyors for the State of Connecticut.

Squadron-Leader K. M. Guthrie, Affi.E.I.C., who was formerly at Fort Osborne Barracks, Military District No. 10, Winnipeg, Man., has been transferred to the Department of National Defence, at Ottawa, Ont.

W. G. Hamilton, S.E.I.C., is now connected with the engineering department of Canadian Johns-Manville Company Limited at Asbestos, Que. Mr. Hamilton graduated from the Nova Scotia Technical College in May of this year with the degree of B.E. in mining.

Professor C. V. Christie, M.E.I.C., Department of Electrical Engineering, McGill University, has been elected vice president of the American Institute of Electrical Engineers for the year beginning August 1st, 1935, as announced at the Annual Meeting of that Institute held recently at Ithaca, N.Y.

The Engineering Institute of Canada Prize Awards 1935

Eleven prizes known as "The Engineering Institute of Canada Prizes" are offered annually for competition among the registered students in the year prior to the graduating year in the engineering schools and applied science faculties of universities giving a degree course throughout Canada.

Each prize consists of twenty-five dollars in cash, and having in view that one of the objects of The Institute is to facilitate the acquirement and interchange of professional knowledge among its members, it has been the desire of The Institute that the method of award should be determined by the appropriate authority in each school or university so that the prize may be given to the student who, in the year prior to his graduating year, in any department of engineering has proved himself most deserving as disclosed by the examination results of the year in combination with his activities in the students' engineering organization, or in the local branch of a recognized engineering society.

The following are the prize awards for 1935:

University of British Columbia	John Richardson
University of Alberta	Frank James Hastie
University of Saskatchewan	Arthur Frederick Burke Stannard
University of Manitoba	Eliot Robertson Davis
University of Toronto	William Murray Lawrason, S.E.I.C.
Queen's University	William N. Simmons
Royal Military College	Robert M. Powell, S.E.I.C.
McGill University	Donald Carman McCrady
Ecole Polytechnique	Louis Trudel, S.E.I.C.
University of New Brunswick	Donald D. Cunningham
Nova Scotia Technical College	E. C. Thomas

Committee on Consolidation

The Committee on Consolidation is making no further report on its work this month, pending the submission to the membership of a complete report on the results of the "Questionnaire" which, it is hoped, will be received from all the Branches and Provincial Professional Associations, by the middle of August.

A Presentation of British Columbia Views on the Federation Problem

*P. H. Buchan, A.M.E.I.C.,**
Past-Chairman, the Vancouver Branch of The Institute

Introduction

In the year 1929, The Institute and the provincial associations of professional engineers agreed to the appointment of a Dominion Committee of Four, composed exclusively of members chosen by the associations, one representing the Maritimes, one for Quebec and Ontario, one for the three Prairie Provinces, and one for British Columbia. This body was appointed to discuss the general question of federation. After making a report in 1931, it was resolved into a Committee of Eight, consisting of one representative from each provincial association. The new body adopted the report of the previous committee and was expected to formulate plans for implementing that report. Since its last meeting in 1933, this committee has been inactive while awaiting the outcome of proposals advanced by Institute committees which disregarded the foundations already laid. The following thesis on the problem, as it occurs in British Columbia, aims to demonstrate to all Institute members, that the only practical way to achieve federation will be to insist on action by and through the Committee of Eight. The Institute is favourably placed to give impetus to this movement.

The Federation Problem—1935

During the past fifteen years, there has been a movement among engineers in Canada to obtain legal power to register and regulate their own profession in a manner similar to the sister professions of law and medicine. Progress, evidenced by the rapid growth of bodies incorporated and clothed with this power under special legislation in eight of the nine provinces, has engendered within The Institute a desire for some simple plan whereby any member who has complied with the law, may, by the payment of one combined fee, secure to himself the rights and privileges of both The Institute and the provincial corporation in which he is registered. This sounds like a simple proposition; but the fact is that its complexities have constituted a problem so baffling in its fundamentals, that not only has no generally acceptable plan been forthcoming, but the resulting controversy has tended to discourage all who have devoted time and energy to its solution.

Primarily, we have to devise a means of co-ordinating two distinct types of professional organization, the one, a Dominion society based on the voluntary principle, the other, a provincial corporation based on the compulsory or licensing principle. This situation is complicated by the presence of other voluntary societies, somewhat differently constituted to The Institute, which nevertheless, have many professionally qualified members whose future relations with The Institute must be given full consideration in any scheme which proposes a federation of The Institute with the profession. Besides, there are the eight provincial corporations of the compulsory type, which vary widely in the application of licensing power. Moreover, within either type of organization, we find extensive variation in the qualifications for admission to corporate and junior membership. Again there are the reactions of the individual members of these organizations to be considered. Some are unable to see any need for a registered or licensed engineer to belong to a voluntary society, if voluntary membership requires the payment of additional dues; some employed engineers who belong to one or more voluntary societies, can see no reason why they should be subject to registration law. Others think that membership in a voluntary professional body ought to be sufficient qualification for admission to any licensing corporation without special formalities, or vice versa. And there are those who are unable to see why either type of professional organization should not suffice for all practical purposes.

It is quite apparent that no plan could hope to satisfy so many conflicting opinions and conditions. Modification of some of them is essential; yet whenever proposals have been submitted which run counter to cherished views on the subject, opposition invariably has arisen to forestall any advancement in the direction suggested. Consequently, the only immediate prospect of attaining federation lies in the promotion of that common understanding of the fundamentals of the problem, which is prerequisite to an acceptance of the views of those who, by dint of lengthy study and experience, have gained a practical knowledge of the subject.

The Engineering Profession in British Columbia

The Engineering Act of the Province of British Columbia became law in 1920, followed by amendments in 1924 and 1927. The Association of Professional Engineers of B.C., incorporated in 1920 under the Act, commenced with a charter membership of about three hundred and fifty professional engineers, admitted on credentials. This body has grown in fourteen years, to a corporate membership numbering about eight hundred and twenty-five, with over five hundred enrolled student engineers who are actively qualifying for corporate status under the Association's Student System.

During the past twelve years, admission to corporate membership has been by examination, exceptions being sparingly granted, and only when the credentials of the candidate place his qualifications unquestionably within the standards prescribed by the Examining Board and the By-Laws of the Association. The jurisdiction of the Association covers all branches of professional engineering; and because over ninety per cent of the practising engineers in the province are registered as corporate members, the Association has indisputable grounds for asserting itself to be "The Engineering Profession in British Columbia."

Enrolment of Profession in B.C.
March, 1935

Branch	Member	Engineer-in-Training	Engineering Pupil	
Civil	446	84	—	
Mining	171	62	—	
Mechanical	101	44	—	
Electrical	71	50	—	
Chemical	15	30	—	Total
	824	270	250	1,344

Civil Branch includes Structural, Railway, Forest, Logging, Municipal, Geographical, Irrigation and Hydraulic.
Mining Branch includes Metalliferous, Coal Mining, Placer Mining, Geological and Metallurgical.
Electrical Branch includes Telephone and Hydro-Electrical.

On this continent the term "engineer" has a somewhat casual meaning, being applied broadly to persons possessing superior technical skill, whose occupations are identified with the general field of engineering. It embraces many skilled artisans or mechanics, as well as the professional practitioners. The resulting confusion has led to the adoption in British Columbia of the term "professional engineer," to mean any person qualified to practise engineering, as distinguished from those who, being merely skilled artisans, are not so qualified.

The Engineering Act of B.C. deals exclusively with the professional man. It applies to all grades of assistant engineers above the grade of junior, as well as the chief and consulting engineers, and makes no distinction whatever between employed engineers and those engaged in private practice. It defines the "practice of professional engineering" in considerable detail, and forbids any person who is not duly registered or licensed, to practise in any branch of engineering falling within the scope and meaning of the definition. The Act also forbids the adoption of the title "professional engineer," or any abbreviation thereof, by persons who are not so registered or licensed, excepting only those who are exempted by special provisions of the Act.

The fundamental principle of the Act is the prescribing and developing of a formal system of training and examination for all who would become members of the profession. Graduation from a school of engineering is not in itself a sufficient qualification. The *fundamental purpose* of the Act is to maintain a high standard of engineering practice in British Columbia, and thereby promote public confidence in all persons who by law, are entitled to call themselves "professional engineers." The Act requires the Association to pass by-laws relating to the government, discipline and honour of its members, and the examination and admission of candidates to the *study* and practice of professional engineering.

The Association maintains its headquarters at Vancouver, and a salaried registrar on a full-time basis. The incumbent of this position since incorporation is E. A. Wheatley, A.M.E.I.C., whose diligent researches in the field of professional organization have won for him an ever-widening reputation as an authority on the subject. The faith of the engineering profession in the continued improvement of its status through the agency of the Association, is represented by the expenditure on this venture since incorporation, of a sum in excess of $150,000, contributed in entrance fees and dues by the active membership. It is noteworthy that no part of this amount has been contributed by the voluntary societies operating in the province.

The Institute in B.C.

Having outlined the scope and purpose of the Engineering Profession in British Columbia, let us now discuss the position of The Engineering Institute of Canada. At the time of writing, the total enrolment in the province consists of roughly two hundred and fifty persons, including those on the non-active list.

*B.C. Electric Railway Co. Ltd., Vancouver, B.C.

Summary of E.I.C. Membership in B.C.

Branch	Corporate Active	Corporate Suspended	Juniors and Students	Affiliates	Total
Civil	161	13	41	4	219
Mining	4	1	2	..	7
Mechanical	7	1	7	..	15
Electrical	3	3	2	..	8
Chemical	..	..	1	3	4
	175	18	53	7	253

Comparison with the preceding statement of membership in the B.C. Association, shows that the ratio of Institute enrolment to that of the Association is about 250 to 1,350 or 18.5 per cent. Moreover 86 per cent of The Institute membership is civil, the mining and electrical branches comprising a mere 6 per cent, whereas in the Association, the mining and electrical branches combined, comprise at least one third of its total enrolment. Obviously The Institute has no grounds whatever for considering itself to be the chief representative of the engineering profession in the province, nor is it capable of determining for the mining, mechanical, electrical and chemical engineers in British Columbia any set policy of professional expansion, without their willing acquiescence. Any move of The Institute that might have the appearance of disregarding the opinions of these engineers would scarcely be conducive to the harmonious relations that are so essential for professional solidarity.

The mining and electrical engineers of the province have a preference at the present time for voluntary societies, namely the Canadian Institute of Mining and Metallurgy and American Institute of Electrical Engineers, which minister to their special needs more effectively than The Institute. That such is the case is regrettable from The Institute point of view, but cannot fairly be denied. However, The Institute is distinguished from these societies by its uniformly professional character as measured by the standards of the Association. It is this kinship which has been chiefly responsible for the favoured position it occupies in relation to the provincial body; also because it comprises the largest single group of registered British Columbia engineers, and because its Dominion charter enables it to function as a national society connecting to a large extent, the professional engineers in all parts of Canada. One means of ensuring a continuance of this sympathy between the "Engineering Profession in B.C." and The Institute, has been the annual invitation extended by the Executive Committee of the Vancouver Branch to the president and registrar of the Association to sit as honorary members of the Executive. That this gesture has been appreciated by the Association, is evidenced by the regular attendance of the registrar at the monthly meetings, and the unstinted co-operation given towards furthering the progress of Institute activities in the province.

Compared with the position of The Institute in other provinces, the eighteen per cent minority ratio of its enrolment in British Columbia will probably occasion no little wonder. This circumstance arises from three main causes; firstly, the fact that notwithstanding its altered name, it has continued to be regarded in British Columbia as the Canadian Society of Civil Engineers; secondly, that the electrical and mining engineers naturally gravitate to their favourite societies, the American Institute of Electrical Engineers and the Canadian Institute of Mining and Metallurgy; and thirdly, that the Association has enrolled practically all the professional practitioners and juniors in the several branches of engineering, with the result that those who have not yet joined one of the voluntary societies, are less disposed to join now, except under the strongest of inducements. Moreover, the influence of the financial depression has been particularly unfavourable to The Institute in the last mentioned particular.

Although a somewhat superficial glance at the situation may give many readers of The Journal the impression that The Institute in their own province occupies a premier position, and that comparison with British Columbia would avail them of little else than a feeling of complacency, the real truth of the matter is that the situation in Canada as a whole clearly resembles that in British Columbia. The latest available figures, compiled by the registrar of the B.C. Association in September 1932, will serve to illustrate the fact.

Province	Corporate Members of Association	Being also Members of E.I.C.	Per cent of Assn.	E.I.C. Corporate Members in Province
Nova Scotia	212	110	52	146
New Brunswick	157	85	54	99
Quebec	1188	667	56	927
Ontario	1206	475	39	1179
Manitoba	260	204	78	166
*Saskatchewan	88	52	59	124
Alberta	262	113	43	161
*British Columbia	824	125	15	193
*B.C. Students 220 E.I.T.† 250 E. Pupils	470	43	9	53
	4797	1801	39	3015

*Improved March, 1935.
†Does not include about 50 graduates (1934).

If to the 1,801 joint members we add the 2,996 members of the associations who are not members of The Institute and the 1,214 Institute members who are not registered in any association, we discover that the ratio of Institute corporate membership to the total is 3,015 to 6,011 or about 50 per cent for the whole of Canada. This figure is representative but cannot be taken as complete because of the unknown content of mining, electrical and other branches of engineers. Admittedly there are wide variations in different provinces; but if the national problem of the engineering profession and the problem of Institute development as related to it, are to be solved on the basis of facts as they exist today, British Columbia men have the fruits of fourteen years of experience to offer as a guide to enlightened thought on the subject.

How the Profession in B.C. was Developed

The natural question that the reader now will ask is how the Engineering Profession in British Columbia developed its present strength from such small beginnings, and what part did The Institute play in the process? To answer the question, it will be necessary to refer again to the history of the professional engineer movement in the province.

In 1919 or thereabouts, the desire for some form of legal regulation, translated itself into an effort to procure legislation based on the "Model Act" recommended by The Engineering Institute of Canada. Unfortunately, The Institute, although recognized as being the leading professional body in the province at that time, did not represent more than about twenty-five per cent of the resident practising engineers. In order to gain the co-operation of the majority of these men, it was necessary to form the B.C. Technical Association, which all could join with a minimum of formality. With this new body solidly behind a committee chosen from its own membership and representing all branches of engineering, legislation was obtained at Victoria in 1920, previously referred to as the "Engineering Act." Armed with that somewhat emasculated document, the committee launched the Association, which has carried on since that year. Shortly afterwards the B.C. Technical Association was disbanded. Incidentally it was found that quite a number of the members of that body could not qualify for admission to the Association and therefore were unable to procure certificates of registration as professional engineers.

The Association at once realized that their weakened Act would not permit the unrestrained use of legal power. There certainly was no complete unanimity of opinion among the resident practitioners regarding the matter of registration. Many believed it ought to apply to everyone but themselves. Also employers as a whole viewed the new movement with some uneasiness, although very few showed open hostility to it, most of them believing that the loopholes in the Act would save them from any uncomfortable situations that might arise.

Early Councils wisely adopted an educational policy aimed to accomplish what legal pressure could not do under the prevailing circumstances. This policy visualized a completely registered and regulated engineering profession in British Columbia, animated by a truly professional esprit-de-corps and genuine loyalty to a formally approved code of ethics. It foresaw the willing endorsement of the registration principle by employers and clients alike, provided it could be established in the public mind that registration meant reliability, competence and fair dealing.

Legal compulsion has been studiously avoided, yet undoubtedly there exists today, a strongly developed esprit-de-corps throughout the B.C. profession, and a record of progress which bears witness that the purposes of the Act and the hopes of the originators have been justified. Fourteen years of struggle against economic conditions, apathy, and destructive criticism and inherent weaknesses in the Act have produced the present strong and virile organization.

The most remarkable feature of enrolment is the very high percentage of employed engineers. The educational efforts of past administrations have procured an immense number of voluntary applications from these practitioners, whereas a threat of legal action would have invited sustained resistance and a very disastrous record of failure. Practising engineers of acknowledged standing, who come into the province, readily comply with the regulations, mainly because they feel that it would not be playing the game to refuse. Little or no trouble has been experienced in respect of licences, with any of them. The same applies on the whole to resident engineers, who have evidenced very little real objection to the authority of the Association in the matter of registration. Moreover, it is now quite customary for chief and consulting engineers to insist that their subordinates be registered as members of the Association, or enrolled in one or other of its junior grades according to their individual attainments—a policy which tends to retain appointments and promotions within the ranks of the profession.

The credit for these highly commendable results is attributable principally to wise and tolerant administration and the very sparing use of legal power; also to the carefully framed educational policy aimed to teach the engineer, the client, and the employer, together with the junior aspirants to professional rank, their parents and instructors, the higher duties, qualifications and ethics of professional life. The noticeable improvement in the status of British Columbia engineers rests partly on the maturing strength of the Association, and partly on the power exercised by the Council, to conduct inquiries into all complaints arising from irregularities in professional conduct, or from failures attributable to negligence or lack of professional qualifications.

The thoroughness and impartiality with which these inquiries are conducted, together with the exercise of disciplinary powers when circumstances warrant, is serving to establish in the public mind that the B.C. profession is soundly constituted and stands for a square deal to both the practitioner and the client.

In cases of evasion of the law or of professional misdemeanour, a privately conducted investigation, followed by a forceful presentation to the culprit of the unethical nature of the practice complained of, backed by the power of organized professional opinion, usually has a salutary effect. The potentialities of this method are based entirely on professional esprit-de-corps. The knowledge that such things simply are not done is a powerful deterrent. The odd successful case of evasion, either of the law or the code of ethics, eventually leads the perpetrator into an untenable position.

Although the present administrative practice of the Association is to some extent in advance of the actual letter of the law, further amendment of the Engineering Act would greatly simplify the process of enforcing obedience in recalcitrant parties. Amendments have been under consideration for several years past, but application for legislation has been withheld, pending the adjustment of certain differences of opinion as to the precise intention of some clauses. Considerable progress has been made of late towards ironing out these difficulties.

Admission by Examination and the Student System

The most important requirement of the Engineering Act of B.C. in the practical sense, is the duty laid upon the Association to pass by-laws providing for "the examination and admission of candidates to the *study* and practice of professional engineering." That clause was inserted in the Act because it was recognized that a successful attempt to raise the status of the profession must depend primarily on a strictly enforced standard of qualifications for all persons entitled to the use of the term "professional engineer." Therefore, admission by examination became a cardinal principle of the Association, and early materialized in a carefully prepared system, administered by a competent Board of Examiners. This principle is the real foundation of "The Engineering Profession in British Columbia."

From the beginning it was evident that, quite apart from the eventual registration of every adult practitioner, provision would have to be made for the education and training of the youth of the province to fit them for admission to the profession upon reaching the qualifying age. The resulting by-laws gave effect to the belief that in the course of a few years, the strength of the Association would be maintained not so much by the annual increment of new practitioners taking up residence in the province, as by the annual influx from the ranks of the junior assistant engineers employed therein. The Association has no power to exercise legal compulsion in this regard, but by virtue of its "Student System," the youth are encouraged to enrol in the successive grades of "Engineering Pupils" and "Engineers-in-Training," and are progressed by prescribed courses of study and examination until they finally qualify for admission under the Act. As before stated, over five hundred of these juniors are enrolled under the "Student System."

The non-university applicant may file his name with the Association at the age of 17, on being sponsored by his employer. At 19 he sits for the Preliminary Examination. At 21 or 22, depending on his progress, he can take the Intermediate, which qualifies him as an Engineer-in-Training. At 25 to 27 he may sit for the Final or Professional Examination.

The university undergraduate in engineering is advised and encouraged to enrol as an Engineering Pupil in his third year. Upon graduation he is granted enrolment as an Engineer-in-Training on application, without being required to sit for the Intermediate Examination. The Final Examination takes the form of a thesis, based on the candidate's experience during the four years subsequent to graduation. However if the curriculum of the institution be not approved by the Council of the Association, the graduate may be required to pass the Intermediate, and will most certainly be required to sit for the full Final Examination before being granted a certificate of registration.

By virtue of this system, not only does the Association promote the advancement of the status of the profession, but it ensures from youth, the development and continuance of a proper professional consciousness throughout its membership, based on the principle that what requires effort to obtain, is thereafter the more highly prized and the more jealously guarded.

The Dissemination of Engineering Knowledge

Up to this point, little has been said about the essential functions of professional organization, which are in a measure, complementary to the business of registering and regulating the profession. These functions, selected from the objects of The Institute, are familiar to readers of The Journal.

"To facilitate the acquirement and interchange of professional knowledge among its members; to encourage original research, and the study, development and conservation of the resources of the Dominion; to collaborate with the universities and other educational institutions in the advancement of engineering education.

"To promote intercourse between engineers and members of allied professions; to co-operate with other technical societies for the advancement of mutual interests.

"To advance the professional, the social and the economic welfare of its members and to enhance the usefulness of the profession to the public."

The provincial corporations in general, and the B.C. Association in particular, are not equipped to maintain these objectives as a whole, although their regular activities must necessarily be concerned with the professional and economic welfare of their members, and very properly, with the advancement of engineering education. Most of the field as outlined, is left clear for the voluntary societies, although the B.C. Association has an auxiliary luncheon organization called the "Engineers' Club," which serves as a meeting ground for professional engineers of all branches in the Vancouver area. The fortnightly luncheon meetings, usually addressed on some topic of general interest to the profession, have become a popular institution and are beneficial in breaking down that sectionalism that is so apt to affect the relations of the various branches of the profession. Moreover, the Club, during the past three or four years, has maintained an Engineers' Relief Committee, which has centralized the efforts that otherwise would have necessitated separate committees in each of the voluntary societies. This work has been efficiently handled through the Registrar's office, and even non-registered men have been aided wherever possible, thus indicating that the professional men are at least actuated by a broad-minded spirit.

In recent years it has often been stated that the principal object of The Institute is the dissemination of professional knowledge. If this assertion be true, it is equally certain that The Institute's activities in that direction do not cover, in the practical sense at any rate, the whole field of engineering, even in the province of British Columbia. There are other prominent voluntary societies engaged in the dissemination of engineering knowledge and the promotion of research—in the mining and metallurgical field for one, and the electrical field for another. Moreover, the number of national industrial associations which maintain committees on engineering matters in connection with their own special branches of industry, is very extensive. The personnel of these committees usually are chief or consulting engineers representing large organizations, with plenty of funds to spend on experimental work under the direction of specialist engineers, the result being the production of reports or papers which in many cases are of outstanding value as contributions to engineering knowledge.

The Institute's activities are of interest mainly to civil, structural and hydro-electrical engineers, although some attention is given to the mechanical and aeronautical branches. Broadly speaking however, electrical, mining, metallurgical, chemical, forestry, and many other specialist engineers have to depend on societies other than The Institute for their professional "stock in trade." These bodies vary in character from something approximating The Institute, to the definitely constituted industrial bodies. The latter type has two main varieties; the one, such as the Canadian Institute of Mining and Metallurgy, being composed of individuals and member companies; the other, such as the Canadian Transit Association, being composed of member companies only.

During recent years, some members of The Institute have advocated reorganization as a technical society, open to all ranks of engineering without special regard to professional qualifications, their aim being a great increase in membership from what the B.C. profession terms the "*skilled* artisan class," thereby enlarging the scope of The Institute as a disseminator of general engineering knowledge. Obviously a body of that character would be face to face with a diversification of activity quite beyond practical limits; and moreover, it would immediately be in open competition with the numerous industrial associations now functioning successfully in almost every branch of engineering. For these reasons, if for no other, the proposal appears to be unsound.

The Skilled Artisans

The term "skilled artisan" is used broadly, to distinguish the mass of persons engaged in the field of engineering, from those who are especially grouped as the engineering profession. The former are men without higher educational qualifications, who comprise the routinists of engineering organization, from which stratum emerge foremen, inspectors, supervisors (such as roadmasters, bridge or building masters, etc.), superintendents and contractors. In this stratum the university graduate and the well qualified practically trained engineer carry on without any distinction or recognition as professional men in the making. The system in force in British Columbia reaches out a helping hand to these men by classifying them and offering guidance to their final training as professional engineers.

Before the advent of the provincial corporations of engineers, The Institute was the only body in Canada whose standards of admission enabled the young graduates and the practically trained aspirants to professional rank, to acquire recognition as professional men in the making. The Institute still performs this service in its own way, and that is the reason why the B.C. Association has raised such strenuous objection to the proposal to lower the standards of admission. A flood of "skilled artisans" entering The Institute on terms of equality with professional men, would entirely destroy the advantages of membership to the latter, and would eliminate any possibility of closer relations with the provincial professional bodies.

Moreover, the fact that the public has been educated to regard membership in The Institute as evidence of professional standing, is a further reason why a general lowering of the standards of admission are regarded with keen disfavour by British Columbia engineers, who have been to such pains and expense to impress upon the public mind, the practical advantages of employing the enrolled pupil engineer, the engineer-in-training and the fully qualified professional engineer, in place of the untrained routinist and the partially qualified engineer. Try to picture the confusion in the public mind, if in their own organization, engineers on the one hand deny professional standing to any person who is not qualified under their own standards, and on the other hand, they themselves disregard these standards as being of no consequence. How could the public be expected to learn the lesson we are at such pains to teach, if they were to observe professional men and "skilled artisans" mingling on a common footing in a supposedly professional society. No amount of explanation would suffice to undo the mischief.

The Engineering Profession in Canada

Having made such noteworthy progress with their provincial organization, and having demonstrated the soundness of their policies and methods of administration, is it to be wondered at that British Columbia engineers have an earnest desire to see their system in effect in every province? They are conscious of having pioneered a way to fuller recognition and appreciation of the engineering profession by engineers themselves as well as by the public. They believe that only so long as the composition and policies of the voluntary societies are at one with the interests of the profession, are such societies entitled to a place in the professional organization.

The Institute is one of the voluntary societies, but notwithstanding the superiority of its membership, numerically and professionally, there are numerous engineers qualified for professional status whom The Institute has not enrolled. The engineering profession, however, embraces all of these men. Therefore, if the proposed extension of professional organization is to effect a condition of complete solidarity, the mining and metallurgical engineers, for example, must be given a voice in both the preliminary and final negotiations. Their society unfortunately is of the industrial type. It meets their own requirements, and we have no right to interfere with its organization or its activities. But on account of its composition, the Canadian Institute of Mining and Metallurgy is not admissible as a body, to negotiations involving strictly professional organization. Consequently it was necessary, a few years ago, to exclude all the voluntary societies from the preliminary discussion of national organization of the profession, in order to avoid any appearance of discrimination. By limiting these discussions to representatives of the provincial corporations, which enrol all practitioners irrespective of their specialist qualifications, this principle was maintained. The final outcome was the report of the "Committee of Eight" in 1932.

That report outlined a general plan for co-ordinating the eight provincial corporations under a Dominion Engineering Council, having in view the eventual equalization of engineering acts, standards of admission to practise, student systems, and administration policy.

The report further recommended a Dominion Engineering Body composed of the membership of the provincial corporations, and intended to function along the lines of The Institute, as a society complementary to the registration or licensing organization. The Institute is thus afforded an opportunity to fit itself for acceptance as the Dominion Body of the Engineering Profession in Canada. Now it should be more than ever evident why The Institute would be acting contrary to its own interests, if it resolved itself into a wide-open industrial body, as some members have advocated.

The Institute's Opportunity

It was expected that active steps to implement the report of the Committee of Eight would soon be taken by the provincial corporations. Unfortunately, however, the apparent lack of appreciation of the real intention of the report, coupled with the absence of a central agency to arouse the provincial bodies to action, has resulted in a marked recession of interest in the matter east of the Rockies. If The Institute could be won over to the undivided support of British Columbia principles, it could, through its Journal and the co-operation of its twenty-five branches, conduct a national campaign to get the movement started afresh.

Successful completion of the interprovincial organization under the Dominion Council would pave the way to fulfilment of the ideal presented herein, of the Engineering Profession in Canada fashioned after the Engineering Profession in B.C. Meanwhile, The Institute, by giving leadership to this movement, would be accorded recognition by practitioners in *all* branches of the profession as their potential Dominion body, thereby assuring its eventual acceptance as such by common consent.

Institute Development

In the opinion of British Columbia professional engineers, any broadening of the basis or lowering of the standards of admission to The Institute, whereby any person "fit to associate with engineers" would be allowed to enrol in The Institute and thus receive its official recognition, is contrary to all principles of a professional body and would be a retrograde step. The common sense policy would be to build up the membership exclusively with professional engineers and professional students.

It is believed that the present corporate membership would quickly sanction as an emergency measure, a resolution facilitating the admission of the registered professional engineer with a minimum of formality the same to apply to all students enrolled in the provincial corporations. Meanwhile, The Institute, in its own interests, should set itself to the task of developing in the other provincial corporations, the same professional philosophy that actuates the Association of Professional Engineers of British Columbia.

Regarding the progression of student engineers through the intermediate grade to corporate membership, the extraordinary disparity in the number of Juniors compared to Students in The Institute List of Members, points to the desirability of active remedial measures. When students are allowed to follow their own devices and drop out because they feel that The Institute has lost its appeal, the resulting tendency to become apathetic to professional duties and privileges is apt to dissuade them from ever seeking enrolment as corporate members. Thus they become lost to The Institute altogether. Does it not appear rather incongruous, that anyone who is following the career of a professional engineer, and who once has felt an urge to become enrolled in The Institute, should, in the ordinary course of events, ever desire to drop out? Why are the Juniors shown in the 1932 List of Members, for example, only 9.5 per cent of the total strength, whereas the Students amount to 19.5 per cent? The depression was not wholly responsible for this discrepancy.

By comparison, the Pupil Engineers enrolled in the B.C. Association in 1934 were 18.5 per cent of the total strength, while the Engineers-in-Training (intermediate grade) were 20 per cent. If The Institute, like the Association, had been paying close attention to the younger element in its membership, it might at this time have had roughly three times the present number of Juniors, most of whom would, in due course, become corporate members. The possibilities of this resource are of practical interest, when compared with the net results of the present practice of increasing the corporate membership by trying mainly to induce fully qualified engineers to join.

Joint Development Before Federation

Coming back to the problem stated at the beginning of this thesis, there does not appear to be any genuine prospect of federation other than by the general procedure recommended by the Committee of Eight. A great deal of study will have to be given to detail arrangements, such as the collection of fees, when the relation of The Institute to the group of eight provincial corporations becomes more clearly defined as their Dominion body. British Columbia engineers believe that the rate of progress will depend on the rapidity with which the principles and objectives herein presented become generally understood and accepted. Co-operation based on uniformity of aims is the commonsense procedure to follow, and the only one capable of obtaining success.

Institute members are urged to apply the knowledge gained in British Columbia to the study of each scheme of federation submitted for their approval. Meanwhile the general situation can be improved by a process of joint development initiated in the following ways:

(1) Recognize and employ the Dominion Committee of Eight to discuss all schemes for the consolidation of the Engineering Profession in Canada. The functioning of this Committee can be facilitated through informal discussions between Dr. Gaby, President of The Institute, and Mr. J. M. Robertson, Chairman of the Committee of Eight; also through frequent meetings of the individual members of the Committee with the executive officers of their respective provincial corporations and the officers of the local branches of The Institute.

(2) It would be advisable to abandon all joint committees now functioning, whose members are not active members of their respective executive bodies. It is essential that the individual committee members shall be in intimate contact with the active conduct of affairs in their respective organizations, otherwise they cannot be truly representative of local opinion.

(3) Invite all registered professional engineers to join The Institute as corporate members with minimum formality, sponsorship by the registrar of the provincial corporation being sufficient for acceptance of the application. For this purpose a special short application form similar to that in use by the C.I.M.M. would suffice. Extend a similar invitation to all students enrolled in the provincial corporations.

(4) Promote the adoption of a professional student system by each provincial corporation, similar to if not identical with the British Columbia system; Institute headquarters and branches to co-operate by encouraging student engineers to enrol in both bodies.

(5) By these means, the establishment of a common membership, both corporate and junior, composed exclusively of professional engineers and professional students will eventuate in consolidation as the Engineering Profession in Canada.

(6) We do not feel at the moment, that the present variation in the qualifications for admission to corporate membership in the eight provincial associations provides sufficient grounds for excluding from The Institute any person who has complied with the law and obtained registration, provided he is vouched for by the registrar or other responsible officer. The fact that by so doing, he has attained legally acknowledged professional status, is the really important point after all. If a few improperly qualified engineers were to slip in during the process, their very small minority would have no appreciable bearing on the objective in view. In any case, the operation of the student system, as in British Columbia, would eventually produce uniformity of training and qualifications for all future admissions, and time would do the rest.

(7) It is, of course, essential for The Institute to do everything in its power to persuade its present unregistered resident membership to acquire registered standing at the earliest possible moment. That is a policy which British Columbia has constantly urged, but which The Institute has neglected to follow. By putting it into effect at once, The Institute would not only be building up its own professional strength and influence, but would gain external support and approbation which would go far towards making its path in life an easier and a happier one.

CORRESPONDENCE

The Foundation Co. of Canada Ltd.
Montreal
May 31st, 1935.

The Editor,
The Engineering Journal,

Dear Sir:—

With regard to the Canadian Standard Forms of Construction Contract which have been approved by The Engineering Institute of Canada and the Canadian Construction Association, to which reference is made in the January and March issues of The Engineering Journal,* I desire to offer some criticism as to their applicability to engineering contracts as distinguished from building construction.

I have no particular comments to make on the form for use when the work is being done for a stipulated sum, as I think this should prove quite satisfactory. In my personal opinion the form for the percentage or fixed fee type of contract is open to a good deal of criticism and would hardly be applicable to certain classes of engineering work. I believe this contract form was originally drawn up for building work and it would doubtless be a workable form of contract for the general run of urban building construction, but I doubt if it would be found entirely satisfactory for, say, a large industrial plant located at a considerable distance from the source of labour and materials.

The relations between the owner and the contractor on a percentage or fee contract are basically quite different from the relations of the two under a lump sum contract. When an owner engages a contractor on a fee or percentage basis he is, or should be, buying the services of an organization which he feels is especially competent to handle the particular project in view. He may or may not engage an organization that has the necessary plant and equipment for carrying out the work, as it is quite common on large projects for the plant to be bought for the account of and charged to the cost of the work. Again it is quite common to find cases where the owner is himself supplying a portion of the organization or is supplying certain services to the contractor or is supplying a portion of the plant. Irrespective of how the details are arranged these must of necessity vary to some extent in each case. The basic principle of the contract is that the owner is paying the contractor a fee for the use of his organization and facilities and for services rendered, the engagement being much the same as the engagement of a lawyer, engineer or other expert acting in a professional capacity. In my own experience the relationship as outlined above is the one that actually exists in the great majority of cases under the fee or percentage form of contract, but I do not think that this basic relationship is recognized in the standard form which has been approved by The Institute.

Under the fixed price type of contract the relations between the owner and the contractor are in general quite different, the basic principle being that the owner is buying, not so much a service as a completed structure or piece of work, the details of which have been carefully specified. Under this form of contract, the extent and character of the work, its quality and the method of executing it, must form an important part of the agreement, and machinery must usually be set up for supervision and inspection, and in general for determining whether or not the work as executed is in fact that which the contractor has agreed to deliver. For this work the owner pays a pre-arranged price, irrespective of the cost. If the cost can be reduced in any way the contractor benefits; if it is increased the contractor stands the loss.

Under the fee or percentage contract the contractor is therefore acting in a sense as a trusted employee of the owner, occupying a position of considerable responsibility, and if he performs his functions properly he is bound to give the owner the best and most efficient service he can, and the whole contract of engagement should recognize that the contractor is working solely in the interests of the owner. In this sense I think that the standard form of contract fails to cover what I think should be the true intent of the agreement.

In the actual working out of a cost plus contract it has been my experience that the most important thing is to have a clear understanding as to exactly what is to be included in the cost of the work, and what items of cost are to be paid out of the contractor's fee. I think that the wording of Article IV, which defines the cost, might be materially improved and clarified. It would appear also that two items of cost which are quite important on many engineering contracts, are not covered at all in this article, namely the cost of building, equipping and operating camps and commissary, the question of profit or loss from same and the cost of securing and transporting labour. I think that paragraph (k) of Article IV is entirely impracticable and wrong in principle for the average engineering undertaking, although it might be workable on an urban building contract. Plant rental and overhead bear no even approximately fixed relation to the remainder of the other costs. A contractor figuring on a given piece of work might be willing to take a very low percentage for this item (k), figuring on executing the work without very much machinery, whereas a contractor figuring on a highly mechanized job might have to ask several hundred per cent and the latter might easily be the more economical way of handling the work. The plant charges for making an excavation by hand are nothing, whereas the plant charges for making an excavation using a modern large capacity shovel or dragline constitute almost the entire cost and might be one thousand per cent of the other costs.

In my opinion there are a great many minor items of cost that are not covered by Article IV, among which I might mention drawings and blue prints, telephone service and telegrams, stationery and office equipment, such as adding machines, typewriters, etc. These items are not in the aggregate of great importance but it is these small things that give rise to disputes if they are not properly covered in the first instance. I think it is equally important that there be another article, corresponding to Article IV stating clearly and concisely what items of cost the contractor is to assume out of his fee.

I think the whole question of plant is badly treated in the standard contract, and as I have stated above, I do not think Clause IV (k) is, generally speaking, workable. The standard contract appears to stipulate only in very general terms that the contractor is to supply plant. Usually the question of plant is considered to be of primary importance by both the owner and the contractor, and the possession by the latter of adequate plant and equipment is often the controlling factor of the engagement. In other cases all plant may be furnished by the contractor and the capital cost of same may be a charge against the cost of the work. In yet other cases certain parts of the plant may be furnished by the owner or may be bought as a part of the cost of the work, and certain other parts may be furnished by the contractor. None of these cases, which are all quite common, appear to be covered in the standard contract. I think every cost plus contract should stipulate exactly what classes of plant are to be furnished by each of the parties to the contract, how it is to be paid for and what disposition is to be made of it when it has served its purpose. Our own practice on lump sum work is to charge to the contract cost depreciation or rental on standard construction plant at stipulated rates for each item, assembling and loading same at a fixed rate per ton, transportation to and from the work, and installation, operation, maintenance, dismantling and repairs. We issue a printed schedule that serves to define what items of equipment are considered as standard plant and a monthly rate for each item. We consider that all special plant and equipment is chargeable to the cost of a particular operation and that rented plant is likewise chargeable to the operation at actual cost. Under a percentage contract we naturally prefer to treat plant in exactly the same way that we would under a lump sum contract, but, if the client prefers, we can modify this system to any degree that may seem desirable, and we have on occasion quoted a fixed sum to include all plant charges.

Engineering contracts quite frequently involve the use of very highly specialized and costly items of plant that are built for a particular operation and are virtually scrapped upon the completion of that operation, or, if they are not actually scrapped, are subject to a very large charge for obsolescence. I cite, for example, the large shovel and draglines used at Beauharnois, or the electric shovels which we ourselves used at Masson and which were built to work in a tunnel of a certain size and grade, and could be used elsewhere only with substantial alteration. I might also cite the many cases of engineering contracts that require the use of tugs, barges, lighters, dredges, derrick boats, etc., each of which is usually treated as a separate operating unit subject to various maritime risks which are usually insured against. I do not think the standard form of contract covers any special plant or equipment of this nature.

It has been the writer's experience that insurance is an item that should be very completely covered in a fee or percentage contract, and I would say that the standard form fails in this. It is possible to insure against almost every conceivable kind of risk, and it is usually advisable for the contractor to call the owner's attention to the various classes of risks that can be covered by insurance, and to recommend in each particular case the risks that should be underwritten and those that should be assumed as a part of the cost of the work. The standard form of contract could, I think, cover this question of insurance in general terms and should in some way cite the various classes of insurance which might be carried, leaving it for those negotiating the contract to insert the details. In support of my criticism of the standard form might I call attention to Article VIII of the General Conditions which would require the contractor to insure the work against loss by fire to the extent of 80 per cent of its total value, bearing in mind that the work might consist, for example, of a concrete dam or might be such that a very large proportion of the cost is represented by excavation or earth fill. Article VII of the General Conditions would apparently require the contractor to insure for personal injury without limit, or himself assume the excess risk, which is I think often quite contrary to accepted practice.

On a large cost plus operation I think it is important that the question of salvaged equipment, tools and materials be adequately covered

*Construction Contracts and Contract Forms, Engineering Journal, January 1935, page 42.

Public Works Tenders and Contracts, Engineering Journal, March 1935, page 142.

in the agreement. By salvaged material I mean special equipment, salvage material from temporary structures, salvage material from camps and commissaries, and such items as pipe and fittings, tools and electrical and other supplies that have been purchased as part of the cost of the work and are consequently the property of the owner. The actual cost of these items will have been very substantial, but their value at the completion of the work may be little or nothing except to someone who has a reasonable prospect of being able to use them at a comparatively early date. The standard contract would leave the determination of the value of this salvage in the hands of the engineer who might have little or no knowledge of the practical end of the construction business, and would probably have an exaggerated idea of the real value of the material concerned. I am quite sure that such an arrangement would be found to be unsatisfactory to all concerned, particularly on a large operation, and would lead to endless disputes.

In conclusion I admit that it is difficult to draw up a standard form of contract that will cover such a broad subject as engineering construction, but I do think the present form could be very considerably improved. So far as my own company is concerned, most of our cost plus contracts have simply consisted of a proposal and an acceptance, the former having attached to it a printed circular stating what is to constitute the cost of the work and what items of cost are to be assumed out of the fee, and a schedule that lists the various items of plant and the monthly rates for each.

Yours very truly,

R. E. Chadwick, M.E.I.C.

R. J. Durley, Esq., Editor,
The Engineering Journal,
Montreal.

30 Howard Street, Toronto,
July 15th, 1935.

Dear Sir:—

The writer does not remember ever reading a more interesting article on a public work than that so ably given in the July, 1935, issue of The Journal by Mr. Alphonse Paradis, M.E.I.C., chief engineer, Department of Highways, Quebec, Que. Apart from the fund of information on Canadian highways, the fittingly interspersed descriptions of great undertakings in foreign countries add colourful value to a good work.

The article is well worthy of intensive study by young engineers for its highly informative and pleasing eloquence in the field of engineering.

Yours very truly,

(Signed) W. P. Chapman, M.E.I.C.

1010 St. Catherine Street West,
Montreal, Que.
July 10th, 1935.

The Editor,
The Engineering Journal,
Montreal, Que.

Dear Sir:—

I have read with interest the article of Mr. D. J. Emrey, A.M.E.I.C., in the June issue of The Journal, and wish to make the following comments on the formulae which Mr. Emrey uses in connection with the design of the curved rib.

May I point out that the formula $H = Pl/8f$ would only be correct if the arch were supported by two hinges on a solid foundation and the load were uniform over the entire span. Such an assumption is really not admissible in this case.

Mr. Emrey does not explain how the formula on page 302 was derived, but it presumably represents the maximum stress at a certain section of the arch. In my opinion that particular formula should not be applied to reinforced concrete sections unless the moment is so small that the section is under compression over its entire area. In other cases than this the result obtained by its use would be quite misleading.

Yours very truly,

E. Nenniger, A.M.E.I.C.

Tilting Test Stand for Bristol Aero Engines

Modern aero engines, and more particularly those employed on military machines, are often required to operate for considerable periods with the axis at a large angle with the horizontal, as for example during climbing and diving, looping the loop and other manœuvres. The conditions of operation are particularly severe during terminal nose dives, and to ensure uniform operation of the engine in all such circumstances, Messrs. The Bristol Aeroplane Company, Limited, Filton, Bristol, have now installed a tilting test stand in their line of test hangars in the engine department. This allows the engine on test to be tilted either up or down to simulate climbing or diving conditions. The stand is a stiff structure built up from rolled-steel sections, the engine mounting being incorporated in a trunnion carried in bearings in the two end frames. This trunnion can be revolved from the test cabin beside the stand through an angle of 180 degrees, so that if required, the engine under test may be made to assume a vertical position to simulate vertical climbing or diving. The feed lines for the lubrication system are actually mounted on the trunnion arm and therefore move with the engine, but the remaining feed lines, together with all the controls, are made with flexible connections so that the movement of the engine shall be as unrestricted as possible. The controls are actuated by means of Arens cables.—*Engineering.*

BOOK REVIEW

The Principles of Motor Fuel Preparation and Application, Volume I.

By A. W. Nash and D. A. Howes. John Wiley and Sons, New York, 1935. 6¼ by 10 inches. Diagrams, Tables. 538 pages. Cloth. $8.00.

Reviewed by Dr. J. B. Phillips, A.M.E.I.C.*

The subject of petroleum and its treatment has already received considerable attention from various authors, and a new book on the subject requires some very sound justification. The authors have turned out the most exhaustive and comprehensive work on the subject of motor fuels that has yet been published. Rapid advances in petroleum technology in recent years to keep pace with the constant demand for new kinds of products make it essential that a new work like this be brought out to bring the subject up to date. This is a task of no small magnitude, and the authors have performed a wonderful service in making available this noteworthy contribution which will unquestionably rank as one of the standard reference works on the subject of motor fuels.

Volume I, which has been received, takes up distillation, heat transfer, cracking, hydrogenation, natural gasoline, refining, storage and distribution; also benzol, alcohol, synthetic and auxiliary fuels. Volume II, in the press, will treat of analysis and examination, sulphur and gum in motor fuels, internal combustion and Diesel engines and fuels, knock ratings, aviation fuels, and specifications in different countries.

The two important unit operations—distillation and heat transfer—are discussed clearly in a fundamental way and their relation to the whole process shown. Heat transfer might well make a chapter in itself, and the references should include "Heat Transmission" by McAdams, and "Industrial Heat Transfer" by Schack, the two most important works on the subject. A very useful problem in the design of a bubble-cap column is completely worked out. Thermodynamics and reaction velocities are introduced briefly but clearly in appropriate places. The Cross, Dubbs, and Gyro processes for cracking are discussed in detail as typical examples.

The chapter on hydrogenation of coals and oils, and on methods of producing hydrogen, is one of the best expositions of this subject available. One of the most interesting chapters is that concerning shale oil, tar sands, creosote, synthetic fuels and carbonization of coal. A great deal of interesting information concerning the recovery of gasoline from natural gas is also given.

In view of the many predictions of early depletion of the world's petroleum reserves, the chapters on benzol, alcohols, and synthetic fuels are of great interest. The discussion of the utilization of grain alcohol as motor fuel is of particular interest to Canadians.

A very long chapter is devoted to refining methods. The use of caustic soda and other bases is discussed fully, as well as the sodium plumbite and sulphuric acid treatments. The newer hypochlorite, sulphur dioxide and adsorption treatments are also taken up in detail. This chapter in itself is an outstanding contribution.

The authors have made a thorough review of the literature in addition to their own researches, and have presented an extensive bibliography in each chapter which should be of great assistance in the study of any phase of the subject. The references are all very recent, and many new patents are also listed.

This book is not in any sense a collection of abstracts and patent reviews of various processes, but is a very thorough treatise of both the fundamental principles and practical methods in the production of motor fuels in all parts of the world at the present time. It discusses chiefly principles, and avoids too detailed descriptions of apparatus The material is written in remarkably clear style and has been carefully checked, only a few minor errors being noticeable.

This book should be of value to the refinery engineer, research chemist, student, as well as to the automotive engineer. Anyone having to do with motor fuels in any capacity will find something new and enlightening in this book.

**Lecturer in chemical engineering, McGill University, Montreal.*

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Mining and Metallurgy, Transactions, 1933-1934.
American Society of Civil Engineers, Transactions, Volume 99, 1934.

Reports, etc.

American Society of Mechanical Engineers:
American standard drawings and draughting room practice, 1935.
American Standard Screw threads, April 1935.

Quebec, Bureau of Mines: Annual report 1933, Part E.

International Tin Research and Development Council:
Technical Publication No. 17, Factors Influencing the Formation and Structure of Hot-Dipped Tin Coatings.

Institution of Structural Engineers:
Report on a standard method for the Preparation of Calculations Relating to Steelwork in Buildings.
Institution of Mechanical Engineers: List of Members 1935.
Toronto Harbour Commissioners: Annual report 1934.
Canada, Department of Mines:
Analyses of coals and other solid fuels, 1932-1933 and 1934.
Canada, Department of the Interior, Forest Service:
Canadian Woods, Their Properties and Uses.
The Smithsonian Institution: Annual report 1933.

Technical Books, etc., Received

Principles of Motor Fuel Preparation and Application, by Nash and Howes. Volume II. (*John Wiley and Sons Inc., New York.*)
The Engineering Index, 1934.

BULLETINS

Wrenches.—The Canadian Ingersoll-Rand Company Ltd., Montreal, have published a 16-page booklet describing and illustrating the applications of their air-operated impact wrench. This is made in two types, 503, non-reversible for applying and tightening nuts and 533 I-R reversible for both applying and removing nuts.

Transformers.—The Canadian Westinghouse Company Ltd., Hamilton, Ont., have issued a 4-page folder describing their type SK distribution transformers. These are single-phase, 25 or 60 cycles, 2,200 to 220/110 volts.

Pumps.—A 16-page bulletin issued by Darling Brothers Limited, Montreal, describes the company's single-stage centrifugal pumps, Class B, of the horizontally split-case double suction type. These are manufactured in a large range of sizes and capacities.

Compressors.—Two 4-page leaflets have been received from the Worthington Pump and Machinery Corporation, Harrison, N.J., which give particulars of their air compressor units, types VS and VA-2, for general industrial uses and for oil and gas engine starting.

Condensers.—A 4-page folder received from the Worthington Pump and Machinery Corporation, Harrison, N.J., describes their folded tube layer arrangement surface condensers of welded steel shell construction. These are manufactured in 7 sizes.

Lathes.—A 15-page bulletin (No. 171) published by the Monarch Machine Tool Company, Sidney, Ohio, describes and illustrates the various types and applications of the Monarch specially tooled semi-automatic engine lathe.

List of New and Revised British Standard Specifications

(issued during April and May, 1935)

B.S.S. No.

416—1935. *Cast Iron Spigot and Socket Soil, Waste Ventilating and Heavy Rainwater Pipes.* (*Revision.*)
Pipes have been arranged in the different grades according to thickness. Alternative dimensions for short radius bends without access doors and dimensions for equal and unequal double branch pipes are included.

555—1935. *Tungsten Filament Lamps for other than General Service Lamps.* (*Revision.*)
Brings together the various schedules for lamps, other than general service lamps, including those issued during the past three years.

602—1935. *Lead Pipes for other than Chemical Purposes.*

603—1935. *Lead Pipes (B.N.F. Ternary Alloy—No. 2).*
The above two specifications provide for pipes from ⅜″ to 6″ diameter according to purposes for which they are to be used. The weight of each size of pipe is specified together with the chemical composition and a turn pin test.

607—1935. *Reinforced Concrete Poles for Electrical Transmission and Traction Supports.*
Specifies standard lengths and strengths together with constructional requirements.

608—1935. *Dimensions of Varnished Cambric Insulated Annealed Copper Conductors for Electricity Supply including Voltage Tests.*
Gives full dimensions of conductors, insulation and metal sheathing and prescribes the voltage test, bending test and timing test for cables for voltages up to 10,000 volts.

609—1935. *Multitubular Horizontal Boilers (Dryback and Waste Heat).*
Deals with materials, construction and workmanship, scantlings, inspection and testing, exclusive of brick work setting and insulation.

610—1935. *The Rating of Rivers for Power Purposes.*
Gives recommendations regarding the basis for computing, and the units for expressing water-power resources for statistical use and for the purpose of making comparisons between different rivers, river-basins, regions and countries.

Copies of these specifications may be obtained from the Publications Department, British Standards Institution, 29 Victoria Street, London, S.W.1, or from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

RUBBER AND ITS USES IN TRANSPORTATION

The regular monthly dinner and meeting was held at the Prince Edward hotel on April 12th, 1935. There were twenty-nine persons present to hear the paper presented by Dr. A. W. Bull, B.S., Ph.D. Mr. Horton, friend and colleague of Dr. Bull, introduced him to the members of the Branch.

The subject of the paper presented was "Rubber and its Uses in Transportation." Dr. Bull explained that the word transportation was very general and that he was limiting his paper to automotive transportation.

Rubber is obtained from rubber trees. Originally, the only source was wild trees but now only one per cent comes from this source, while cultivated trees supply the balance.

The tropical regions are the main sources of latex, which is the sap from the rubber tree. It is five years before a seedling is large enough to tap. The tree can only be tapped every other day and will only produce 50 cu. cent. per tree per day. Bud grafting and seed selection have aided production. There are now approximately 5,000,000 acres of rubber trees under cultivation.

Latex is unstable as it ferments easily and creates a very bad odour. The standard practice of removing the rubber is to coagulate it by the use of acetic acid. The coagulate is washed, squeezed and dried. This reduces the weight of the raw product for shipping purposes. A second method of treating the latex, is to spray it into a warm atmosphere. The liquid is volatile and disappears and the crude rubber settles. The price of crude rubber has fluctuated immensely: 1910—$2.00 per pound; 1921—15c. per pound; 1925—72c. per pound; 1931—3c. per pound; and at present is going up. United States has 58 per cent of the world's production. Of this 58 per cent, 80 per cent is used in tires and tubes. Reclaimed rubber is also a source as 25 per cent of crude rubber is reclaimed. Attempts have been made to commercialize the following sources: Shrubs, golden rod and synthetic rubber. Synthetic rubber (Dupreen by Dupont) is not affected by oils or organic solids and is resistant to checking or cracking in the sun light. Crude rubber softens and becomes sticky in the sun light. It is hard and brittle at low temperatures and has a high permanent set. Crude rubber is used for crepe rubber soles, gum and surgical bandages.

Vulcanization of rubber discovered by Charles Goodyear is the heating of rubber (usually 220 degrees F. or approximately 50 pounds steam pressure) mixed with about 1 per cent to 3 per cent sulphur. More than 5 per cent of sulphur added makes the mixture leathery while 25 per cent or over of sulphur makes hard rubber. White lead and litharge accelerates the vulcanizing. Carbon black is used as a filler in the manufacture of tires. Small amounts of fatty acids and zinc oxide are used as an anti-oxident. The rubber mill consists principally of a pair of rolls through which the crude rubber with the added ingredients is worked back and forth. This mixture is placed in the necessary dies and formed. The vulcanizing is done by steam heat while still in the dies.

The good properties of this rubber are:—

1. It stretches and has no yield point.
2. It has hysteresis. That is, it does not return all the energy put into it.
3. Under compression, it will distort if free to expand.

The poor properties are:—

1. It will not stand high temperatures.
2. It deteriorates with age.
3. It will take a permanent set if it is exposed to sun light and repeated flexings.
4. Its hardness and resistance are affected by temperature.
5. It becomes swollen if in contact with gas or oil.

Dr. Bull accompanied his paper by slides and demonstrations. He gave a long list of parts with which the rubber industry supply the automotive manufacturer.

The meeting was thrown open to questions. Dr. Bull stated that rubber paving had been tried but not commercialized. In bonding rubber to steel, the steel is first brass plated in order to obtain high adhesion. Deterioration in rubber lined tanks may be retarded by immersion in water. It is also possible to rubber line ash pumps or sand impellors very effectively.

A hearty vote of thanks moved by T. H. Jenkins, A.M.E.I.C., and seconded by E. M. Krebser, A.M.E.I.C., were extended to Dr. Bull and his colleague, Mr. Horton.

Lakehead Branch

G. R. McLennan, A.M.E.I.C., Secretary-Treasurer.

At the annual meeting of the Lakehead Branch of The Institute held on June 18th, 1935, the results of the election by ballot for the Executive for the coming year were announced.

At the Executive meeting held on June 27th, chairmen for the various committees were appointed as follows:

Membership................P. E. Doncaster, M.E.I.C.
Finance....................J. Antonisen, M.E.I.C.
Programme................J. A. Rogers, S.E.I.C.
Reception..................R. B. Chandler, M.E.I.C.

P. E. Doncaster was appointed chairman of a committee to study the matter of co-ordination of The Engineering Institute of Canada and the Professional Engineering Associations of Canada. This committee will bring in a complete report at a special meeting to be held in the early part of September.

The membership committee of the Branch has already begun work on the matter of increasing its membership, and the programme committee is going into the matter of the purchase of a moving picture machine.

Moncton Branch

V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.

ANNUAL MEETING

The annual meeting of the branch was held on May 30th, 1935. H. B. Titus, A.M.E.I.C., vice-chairman for the past season, presided. The annual report and financial statement was presented, and approved on motion of James Pullar, A.M.E.I.C., seconded by R. H. Emmerson, A.M.E.I.C. A vote of thanks to the retiring officers was moved by A. S. Gunn, A.M.E.I.C. The incoming chairman, Mr. Titus, addressed the meeting briefly, thanking the members for the confidence they had reposed in him.

The officers for the year 1935-36 were announced as follows:

Chairman	H. B. Titus, A.M.E.I.C.
Vice-Chairman	G. L. Dickson, A.M.E.I.C.
Secretary-Treasurer	V. C. Blackett, A.M.E.I.C.
Executive Committee	F. O. Condon, M.E.I.C.
	T. H. Dickson, A.M.E.I.C.
	A. S. Gunn, A.M.E.I.C.
	Jas. Pullar, A.M.E.I.C.
	C. S. G. Rogers, A.M.E.I.C.
	G. C. Torrens, A.M.E.I.C.
Ex-officio	H. J. Crudge, A.M.E.I.C.
	J. G. MacKinnon, A.M.E.I.C.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

VISIT TO AIRPORT

On Saturday afternoon, June 22nd, 1935, through the co-operation of the Department of National Defence and of Messrs. Canadian Colonial Airways, over one hundred ladies and members of the Branch visited the St. Hubert airport, viewing the meteorological instruments, two-way wireless and mooring tower apparatus, and the new aerial beacon installation.

About seventy-five took advantage of the opportunity to make a fifteen-minute flight in a new eight-passenger transport plane of the Colonial Airways.

Later, through the courtesy of Mr. Passmore, managing director of Fairchild Aircraft Limited, a number of members and friends inspected the Fairchild plant and air harbour at Longueuil.

In spite of the inclement weather those attending spent a most enjoyable afternoon.

JUNIOR SECTION

Through the kindness of the Harbour Commissioners of Montreal, on the afternoon of July 20th, fifty members of this section made an inspection trip of the harbour on the *S/S Sir Hugh Allan.*

Some three hours were spent in viewing the structures and works in the harbour, particulars and technical information being furnished by the representatives of the Commissioners who were on board, Messrs. Frost, Sparkes and Roberts. Refreshments were served during the afternoon, the trip being thoroughly enjoyed by all present.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The annual meeting was held at the General Brock Hotel, Niagara Falls, on May 31st, 1935, with W. R. Manock, A.M.E.I.C., in the chair, and President F. A. Gaby, M.E.I.C., as the principal speaker.

A number of guests were present, including Chairman W. Hollingworth, M.E.I.C., and Councillor F. W. Paulin, M.E.I.C., of the Hamilton Branch. Vice-President E. G. Cameron, A.M.E.I.C., sent a letter regretting his absence due to unavoidable pressure of official duties.

Councillor Walter Jackson, M.E.I.C., introduced Dr. Gaby as being an acquaintance of old with the residents of Niagara Falls and took occasion to review some of the aspects of engineering consolidation with the Provincial Associations in Canada.

SOME PROBLEMS OF TRANSPORTATION

Dr. Gaby pointed out that our economic structure is based very largely on the development and use of power and transportation, and these are of such importance that our civilization, with present standards of living, could not exist without them. This was recognized at the time of Confederation by our governments of that day, when they wrote into the Agreement of Confederation many matters providing for the creation and maintenance of adequate transportation facilities between the east and west, which, along with power, have become most important factors in the growth and development of our country, and the establishment of large industrial centres such as exist in the southwestern portion of Ontario.

In Canada, many miles of railways were built which are yet maintained upon social and political grounds rather than as being justified by the financial return they produce. British Columbia made her entry into Confederation dependent upon the construction of a transcontinental route which was only built after tremendous obstacles had been surmounted. Between the years 1900 and 1916 came an era of competition and expansion between the railway companies, aided by various Governments, during which period the existing mileage of 17,500 was more than doubled.

Dr. Gaby then illustrated the rapid advance in the development and use of motor vehicles and aeroplanes in commerce, and pointed out that free-for-all or unregulated competition is not economic and results in wasteful duplication and multiplication of services.

Attention was also drawn to water transport, and the necessity that those responsible for railway economics should keep this competitor in mind.

To meet these varied forms of transportation, the railways must also progress; better service, higher speeds, air-conditioning of passenger cars and many other improvements must be planned. Under the present conditions of strict economy, particularly regarding capital expenditures, these problems will call for statesmanlike forethought in their solution.

At the conclusion of this address our new chairman, Paul E. Buss, A.M.E.I.C., proposed the vote of thanks, which was heartily applauded, and the meeting adjourned.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

Le 8 mai dernier, environ quarante-cinq convives assistaient à un déjeuner-causerie au Château Frontenac. Le conférencier, M. A. O. Dufresne, M.E.I.C., Directeur du Service des Mines de la Province de Québec, nous fit une très intéressante causerie intitulée "Les risques de la prospection."

Au début de sa conférence, M. Dufresne souligna l'importance qu'a prise l'industrie minière dans notre province et dit qu'au cours des derniers douze mois, les articles tirés su sous-sol ont fourni 27 pour cent de la valeur totale des produits exportés par notre pays. La prospection dans notre province a commencé en 1922, lors de la découverte de la mine Horne dans le canton de Rouyn; cinq ans plus tard, la compagnie Noranda expédiait les premiers lingots de cuivre. Par la suite, plusieurs compagnies ont entrepris des travaux, et en 7 ans, cette région avait produit pour une valeur de $90,527,000 de métaux.

Le conférencier affirme, avec chiffres à l'appui, que cette industrie a rapporté plus qu'elle n'a coûté, puis, en comparant le nombre de claims enrégistrés avec le nombre de ceux qui possèdent des gisements exploitables déterminés par des travaux souterrains, il en arrive aux probabilités de deux claims profitables pour 1,000 claims jalonnés, un claim en exploitation pour 1,000 jalonnés et deux sur 10,000 payant des dividendes après 13 années de prospection. En terminant, M. Dufresne démontra que la prospection entre dans le domaine de l'ingénieur à qui il appartient de la diriger et de l'organiser.

Le conférencier fut présenté par M. Hector Cimon, M.E.I.C., alors président de notre section, puis M. Adrien Pouliot, I.C., professeur à l'Ecole Supérieure de Chimie le remercia.

ASSEMBLÉE ANNUELLE

L'assemblée annuelle de notre section fut tenue au Palais Montcalm le 20 mai dernier.

Au début, l'assemblée était présidée par M. Hector Cimon, président sortant de charge, et pendant que les scrutateurs dépouillaient les bulletins de votation, l'on procéda à la lecture des minutes de l'assemblée précédente, du rapport du conseil et du trésorier; les divers comités furent formés puis la proclamation des officiers élus fut faite comme suit: Président, Alex. Larivière, M.E.I.C.; vice-président, J. T. F. King, A.M.E.I.C.; secrétaire-trésorier, Jules Joyal, A.M.E.I.C.; conseillers, L. P. Methé, A.M.E.I.C., J. G. O'Donnell, A.M.E.I.C., et J. B. Dunbar, A.M.E.I.C.

M. Cimon invita alors M. Larivière à monter sur le fauteuil présidentiel. Un vote de sincères remerciements au président sortant de charge est proposé et adopté à l'unanimité, puis le président élu fait une courte allocution à l'assistance pour remercier ses confrères de l'honneur qu'ils lui font, et de la confiance qu'ils mettent en lui; il les assure de son plus entier dévouement pour travailler au bien-être de notre association en général et de chacun de ses membres en particulier.

Saint John Branch

F. A. Patriquen, Jr.E.I.C., Secretary-Treasurer.
H. P. Lingley, S.E.I.C., Branch News Editor.

On May 9th, 1935, the Saint John Branch held its annual dinner and meeting at the Riverside Golf and Country Club. Reports of the various committees were read and the election of officers held. Reorganization was also discussed. It was moved and seconded that the Saint John Branch go on record as favouring reorganization and that a committee of two be appointed to study the matter and to meet with like committees from the Moncton Branch and the Provincial Association. During the dinner, in response to a toast to The Institute, Mr. Roland Bustin sang Kipling's "Sons of Martha," which has been set to music by Mrs. A. J. Collins of Walkerton, Ont.

Preliminary Notice

of Applications for Admission and for Transfer

July 29th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in September, 1935.

R. J. Durley, Secretary.

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*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, whicb period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of tbe Council, be reduced to ten years in the case of a candidate for election wbo bas graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member sball be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a scbool of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by tbe Council. The candidate shall be examined on the theory and practice of engineering, with special reference to tbe brancb of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners tbat he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if tbe candidate bas held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at tbe discretion of the Council if the candidate for election has graduated from a scbool of engineering recognized by the Council. He sball not remain in tbe class of Junior after he bas attained the age of thirty-three years, unless in tbe opinion of Council special circumstances warrant the extension of this age limit.

Every candidate wbo has not graduated from a scbool of engineering recognized by the Council, or bas not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to tbe examiners that be has attained an equivalent standard.

A Student shall be at least seventeen years of age, and sball present a certificate of baving passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He sball eitber be pursuing a course of instruction in a scbool of engineering recognized by the Council, in which case he shall not remain in tbe class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in whicb case be sball pass an examination in sucb of the subjects set fortb in Scbedule A of tbe Rules and Regulations relating to Examinations for Admission as were not included in the higb scbool or matriculation examination which he has already passed; be shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant tbe extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but wbose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give tbe names of certain members as reference does not necessarily mean tbat their applications are endorsed by such members.

FOR ADMISSION

BAKER—JAMES DAVIDSON, of Edmonton, Alta., Born at Charlton, Kent, England, Feb. 20th, 1883; Educ., Boissevain Public Schools, Man., 1895-1901; 1902-03, inspr. (Winnipeg), 1903-05, inspr. (Calgary), and 1905-07. chief inspr. (Calgary), Bell Telephone Company; 1907 to date (except 1916-19, overseas, Lieut., Can. Signal Corps), with Alberta Govt. Telephones as follows: 1907-08, constrn. foreman; 1908-10, local mgr., Macleod; 1910-13, district plant mgr., Calgary; 1913-16, asst. to plant supt., Edmonton; 1919-20, constrn. engr.; 1920-29, plant supt., in charge of constrn. and mtce. of all physical property; 1929 to date, Deputy Minister of Telephones and General Manager, Alberta Govt. Telephones.

References: R. S. L. Wilson, H. J. MacLeod, G. H. Thompson, F. K. Beach, B. L. Thorne, L. C. Charlesworth, C. E. Garnett, J. B. deHart.

CALDER—WILLIAM, of Edmonton, Alta., Born at Edinburgh, Scotland, April 11th, 1877; Educ., Goldsmith's Institute, London, England, 1894-95; Member, Inst. Mining Engrs., England. Member, Inst. Petroleum Technologists, England; 1895-97, ap'tice mech'l. engr., London, England; 1897-99, pupil, mining engrg., Kent Coal Exploration Co., Kent, England; 1899-1900, learner with Thoms Ltd., Manchester, well contractors; 1900-03, jr. engr. and oil lease asst. supt., Baku Russian Petroleum Co.; 1903-05, asst. oil fields mgr., Schibrieffs Petroleum Co., Baku, Russia; 1905-06, private reporting work, London, England; 1906-07, mgr. in charge oil prospecting, Portugese Petroleum Syndicate; 1907-08, mine prospecting supt., Russo Asiatic Corpn., Siberia; 1908-09, supervising oil prospecting, Caledonian Petm. Syndicate, South Africa; 1909-11, gen. oilfield supt., S. Pearson & Son Ltd., Mexico; 1911-13, oilfield mgr., Anglo Maikop Corpn., Russia; 1913-14, private advisory work, London, England; 1915-17, reorganizing oil companies, International Oilfields, Russia; 1917-19, war service, Capt., Royal Engrs.; 1920, asst. oilfields mgr., Anglo Persian Oil Co.; 1921-22, gen. mgr., Kern Trinidad Oilfields; 1922-24, adviser for concession negotiations, Anglo Maikop Corpn., Russia; 1925, inspecting copper mines, Flinders Range Copper Co., Australia; 1926-30, petroleum engr., and 1931 to date, director, petroleum and natural gas divn., Dept. of the Interior, Alberta Govt., Edmonton, Alta.

References: S. G. Porter, B. L. Thorne, R. S. L. Wilson, E. Stansfield, L. C. Charlesworth, S. G. Coultis.

DOUGLAS—JOHN HOLDEN WEBB, of 10937-90th Avenue, Edmonton, Alta., Born at Amherst, Victoria, Australia, Nov. 27th, 1879; Educ., 1895-1902, five years ap'ticed to John Danks & Son Proprietary Ltd., Engineers, South Melbourne, engrg. trade of turning and fitting, and two years as journeyman engine lathe hand on high grade engine work. During this period attended the Working Men's College and Technical School, Melbourne; Member, Assn. of Prof. Engrs., Alta.; 1902-04, seagoing engr., passing for Marine Second Class Cert. in 1904, and for 1st Class British Board of Trade Cert. in London, England, in 1905; 1905-08, McIlwraith McEacharn Line of London and Melbourne; 1908-12, employed in open air work, including only three small engrg. jobs; 1912, machinist and engr., in Red Deer and Medicine Hat, Alta.; Jan. 1913, passed for Alberta 1st Class Cert., and appointed master mechanic to Hillcrest Collieries, Crows Nest.; May 1913, appointed inspr. of boilers and machinery for the Red Deer District of Alberta; June 1928 to date, mech'l. supt. in charge of Alberta Provincial Government Power Plants, Dept. of Public Works, Edmonton, Alta.

References: H. P. Keith, R. S. L. Wilson, C. E. Garnett, F. K. Beach, R. J. Gibb, A. Ritchie.

FINDLATER—RICHARD HAMILTON, of 74 Highfield St., Moncton, N.B., Born at Uphall, Scotland, Aug. 10th, 1886; Educ., 1904-08, Heriot-Watt College, Edinburgh. Fellow, Institute of Chemistry. Member Inst. Petroleum Technologists. Member, Soc. of Chemical Industry; With the Broxburn Oil Co., Broxburn, Scotland, as follows: 1900-04, junior asst. chemist, 1908-11, second asst. chemist, 1916-21, chief asst. chemist; 1911-15, chief chemist and refinery manager, British Australian Oil Co. Ltd., Newcastle, N.S.W.; 1915-16, reporting on prospects, of shale oil industry in Nevada, U.S.A.; 1921-24, refinery manager, Egyptian Govt. Petroleum Refinery, Suez, Egypt; 1925-33, petroleum chemist, refinery specialist, asst. manager, New Brunswick Gas and Oilfields Ltd., Moncton, N.B.; 1934 (6 mos.), supt., Wetumka natural gas field, booster plant and gasoline absorption plant, Central States Power and Light Corporation, Tulsa, Okla., U.S.A.

References: F. O. Condon, C. S. G. Rogers, H. J. Crudge, G. E. Smith, V. C. Blackett.

FORTIN—JEAN JULIEN, of Chicoutimi, Que., Born at Baie St. Paul, Que., Mar. 2nd, 1910; Educ., B.Sc., Queen's Univ., 1934; Summers, 1932, surveying, 1933, gen. repairs, elec. power plant, Isle Maligne; 1934 to date, with Duke Price Power Co., topog'l. surveys, and at present tracer and designer at Arvida office.

References: F. L. Lawton, D. M. Jemmett, D. S. Ellis, E. Lavoie, R. E. Joron.

HARDY—WILLIAM GATHORNE, of 4879 Patricia Avenue, Montreal, Que., Born at Tamworth, England, Sept. 28th, 1888; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1920; N.S.L.S., R.P.E. of Que.; Formerly Assoc. Member E.I.C. and Inst. C.E.; Articled pupil to borough engr., Stafford, England; 1914-15, asst. town engr., St. Lambert, Que.; 1915-18, overseas, Capt., Can. Engrs.; 1919-27, asst. prof. of civil engrg., Nova Scotia Technical College, Halifax; 1927, chief engr., Parsons Constrn. Co., Moncton, supt. of constrn., Foundation Co. of Canada; 1927-31, chief engr., Bolivian Power Co., La Paz, Bolivia; 1931-35, chief designer, Montreal Sewers Commission.

References: W. H. Munro, F. R. Faulkner, W. Griesbach, G. R. MacLeod, A. C. D. Blanchard, W. S. Lea, I. A. Vallieres.

HERR—ARTHUR GEORGE, of 131 York St., St. Catharines, Ont., Born at Wartburg, Perth Co., Ont., Oct. 18th, 1886; Educ., Archtl. and Electl. Engrg. Course, I.C.S.; 1903-10, carpentry and general bldg. constrn.; 1911-14, in archtl. office of A. E. Nicbolson; 1915-16, inspr. of munitions; 1917 to date, cbief dftsman, in charge of all mechl. engrg., Packard Electric Co. Ltd., St. Catharines, Ont.

References: L. P. Rundle, S. Hairsine, G. F. Vollmer, C. G. Moon, J. B. McAndrew, A. L. Mudge.

ROBERTSON—IAN ANSLEY, of 275 Erskine Ave., Toronto, Ont., Born at Stirling, Ont., May 24th, 1906; Educ., 1922-26, Central Technical School, Toronto (completed course but did not sit for exams. although standing indicated he would have been successful in obtaining diploma). 3rd year night school in machine design. Home study (applied mechs., thermodynamics and electricity); 1927-28, dftsman., Gunnell Co. of Canada, Toronto; 1928-29, dftsman., Lincoln Meter Co. Ltd., Toronto; 1932, International Cooler Corpn., dfting, etc.; 1932, beating and contracting jobs; 1929, and intermittently since then, with Water Equipment Ltd., Toronto, assting in design and erection of a small water works plant, etc.; 1929-31, and 1934 to date, with the Canadian National Telegraphs, inside and outside plant constrn., and at present dftsman.

References: M. B. Watson, H. N. Gzowski, A. S. Cook, V. S. Thompson, W. B. Redman.

WHITE—JOHN, of 4539 Harvard Ave., Montreal, Que., Born at Glasgow, Scotland, April 10th, 1903; Educ., 1918-25, Royal Technical College, Glasgow; One year sanitary engrg. (Inspection and Legislation); 1918-23, ap'tice engr., with Fairchild Shipbldg. and Engrg. Co. (Engrg. Dept.), at Govan, Scotland, in conjunction with college courses; 1923-24, engr. on constrn. and erection of all types of marines engines, boilers and auxiliaries (same company); 1924-27, asst. engr. on tests and shop trials of marine, reciprocating engines, Parsons' and Brown-Curtiss,' direct drive, single reduction, and double reduction, gear coupled turbines, also Sulzer oil engines; 1927-28, sales engr. with Williams & Wilson, Montreal, in charge of pumps and pumping equipment; 1928-29, asst. to eng. in charge of dept. of operating records, Price Bros. & Co. Ltd., Kenogami, Que., duties chiefly measurement of all steam generated and distributed in the mill, also efficiencies of various boilers, engines, machines, etc.; 1929 to date, engr. in charge of bldg. service (mtce. dept.), Sun Life Assurance Co. of Canada, Montreal, Que.

References: K. T. Cregeen, A. J. C. Paine, E. A. Ryan, R. F. Legget, N. D. Paine.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BUCHAN—PERCY HALCRO, of 1984 West 41st Ave., Vancouver, B.C., Born at Toronto, Ont., Oct. 8th, 1886; Educ., B.A.Sc., (Mech. and Elec.), Univ. of Toronto, 1909; R.P.E. of B.C.; 1904-06, shop ap'tice, Hinton Electric Co. Ltd., Vancouver; 1907-08, (summers), junior dftsman., Grant and Henderson, Arch'ts., Vancouver; 1916-18, overseas, C.E.F., Lieut.; 1909 to date (except war service), with the B.C. Electric Rly. Co. Ltd., Vancouver, as follows: 1909-12, clerical work in field and office on materials, costs, progress estimates, etc.; 1913-15, asst. engr. on tramway extensions and improvements; 1919 to date, chief dftsman and asst. engr. in charge of design, estimates, constrn. and mtce. on Vancouver city lines. Also—1919-20, in charge of track, 1924, in charge of floor area survey for domestic lighting on lower mainland, and in charge of various special reports. (*A.M. 1919.*)

References: A. C. Eddy, E. E. Carpenter, A. S. Wootton, W. H. Powell, E. A. Wheatley.

DORMER—WILLIAM JOHN SMYLIE, of 4038 Beaconsfield Ave., Montreal, Que., Born at Middlesborough, Yorks, England, Dec. 2nd, 1899; Educ., B.Sc. (E.E.), McGill Univ., 1923; 1918, overseas one year, R.A.F.; Summer work — 1920, lineman, Southern Canada Power Co.; 1921 and 1922, asst. operator and system operator, City of Sherbrooke Gas and Elec. Dept.; 1923 to date, with the Bell Telephone Company of Canada, Quebec Division Plant Engrg., as follows: 1923-25, student engr.; 1925-28, asst. field engr., investigation of inductive and struct'l. co-ordination between power and telephone lines, and investigation of location for new pole line from Riviere du Loup to Edmundston, and preparation of estimate for same; 1928-29, res. field engr., Riviere du Loup to Edmundston, and Madoc and Smiths Falls, Ont.; 1929-30, divn. toll line engr., supervisor in charge of toll pole line work, including staking new pole lines, estimating, budgeting, etc.; 1930-34, divn. toll plant engr., in charge of all toll plant work in Quebec divn. Budgets, estimates, cost studies, scheduling, etc.; June 1934 to date, district engr. (Montreal Suburban and Three Rivers Districts), in charge of all toll and exchange plant work in the two districts. Budgets, estimates, cost studies, additional facilities and relief projects, scheduling, etc. (*St. 1920, Jr. 1927, A.M. 1933.*)

References: J. L. Clarke, R. DeL. French, A. M. Mackenzie, C. V. Christie, R. H. Mather, D. H. McDougall, A. C. Abbott.

GILBERT—GORDON MACDONALD, of Vancouver, B.C., Born at Ottawa, Ont., June 2nd, 1899; Educ., B.Sc. (C.E.), Univ. of Man., 1926; Member, Assn. Prof. Engrs., of B.C. 1915 to 1923, part time work in various positions as follows: rodman and chainman, surveying gold claims, Nor. Man.; mtce. work with C.P.R.; mechanic, Flying Corps; leveller, C.P.R.; topographer D.L.S. parties; straw boss on steel gang at Great Falls constrn. power plant; field engr. on municipal development work in Chicago; asst. in charge of ground control on topographic mapping, Alta.; 1924 (Jan.-May), dftsman., on design of govt. elevator at Edmonton, for C. D. Howe & Co.; 1924 (May-Nov.), topographer and asst. on photo-topographic map of Kamloops area; 1925 (Jan.-May), field engr. with Phoenix Utility Co. on location and prelim. constrn. of power plant; 1926 to date, continuously employed by the Vancouver and District Joint Sewerage and Drainage Board, as asst. to the chief engr., res. engr. on different constrn. jobs, and at present supt. and acting-engr. of the Board. (*A.M. 1934.*)

References: J. Robertson, A. S. Wootton, E. C. Thrupp, G. L. Tooker, E. A. Wheatley.

ROBERTSON—JAMES, of 5888 Adera St., Vancouver, B.C., Born at Kilmarnock, Scotland, Aug. 11th, 1890; Educ., B.Sc. (Civil), McGill Univ., 1914; 1904-07, engrg. ap'tice, Glenfield & Kennedy Ltd., Kilmarnock; with the Dominion Bridge Company Ltd., as follows: 1907-10 and Summers 1911-12-13, dftsman and checker, Lachine; 1914-18, designing engr., Montreal office; 1918-29, erection engr., Montreal and Lachine; 1929 to date, engr., Pacific Division, Vancouver, B.C. (*St. 1913, A.M. 1916.*)

References: F. P. Shearwood, D. C. Tennant, F. Newell, P. H. Buchan, W. H. Powell.

STUART—HAROLD BROWNLEE, of 17 Highcliffe Ave., Hamilton, Ont., Born at Mitchell, Ont., Jan. 31st, 1889; Educ., B.A.Sc., Univ. of Toronto, 1908; 1906, farm drainage, Perth and Huron counties; 1908, instr'man., Calgary District, Alberta Govt.; 1910, detailer, Hamilton Bridge Co.; 1909-10, chief engr., The Peoples Railway; 1911, (Jan.-May), detailer and checker, Canada Foundry Co.; 1915-19, overseas, Major, Can. Engrs.; With the Hamilton Bridge Co., Hamilton, Ont., as follows: 1911, detailer and checker, 1912-15, and 1919-21, designer and surveyor, and 1921 to date, field engr. (*A.M. 1920.*)

References: R. K. Palmer, W. F. McLaren, F. W. Paulin, E. P. Muntz, W. Hollingworth, J. A. McFarlane, G. A. Colhoun, A. Love.

THRUPP—EDGAR CHARLES, of 2626 13th Ave. West, Vancouver, B.C., Born at Adelaide, South Australia, June 8th, 1863; Educ., 1873-79, private schools in England; 1879-82, applied science dept., Kings College, London; 1882-84, articled pupil, 1884-86, junior asst., and 1886-1901, chief asst. to Prof. H. Robinson, M.Inst. C.E., London, England; 1901-08, private practice in London; 1908 to date, private practice, Kamloops and Vancouver, B.C. (*A.M. 1915.*)

References: J. Robertson, H. N. Macpherson, G. M. Gilbert, C. T. Hamilton, P. Sandwell, G. L. Tooker, A. S. Wootton, P. H. Buchan, J. P. Mackenzie, F. O. Mills, E. A. Wheatley.

WHEATLEY—EDWARD AUGUSTUS, of Vancouver, B.C., Born at Lowestoft, England, Aug. 22nd, 1885; Educ., 1901-05, ap'tice to S. J. Johnson & Co. Ltd., Engineers, Stratford, England, and for two years of this time, evening courses at City and Guilds Technical College, London, England. Member, Assn. Prof. Engrs. B.C.; 1905-08, engr. to Sir Hiram Maxim and the Electric and Mtce. Co., office and works management; 1909-11, railway surveying and operating rock crusher plant with the C.P.R. in B.C.; 1911, 2nd engr. to The Edmonton Brick Co.; 1911-14, engr. and supt., Alsip Brick Co., Edmonton, Alta.; 1914-18, overseas., Capt., Royal Engrs., M.C. and Bar; 1921 to date, Registrar, Association of Professional Engineers of the Province of British Columbia, Vancouver, B.C. (*A.M. 1921.*)

References: J. Robertson, A. S. Wootton, H. N. Macpherson, E. C. Thrupp, J. P. Mackenzie, G. L. Tooker, P. H. Buchan.

FOR TRANSFER FROM THE CLASS OF JUNIOR

FOX—JOHN H., of 37 Macdonell Ave., Toronto 3, Ont., Born at Toronto, May 24th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1927; 1924-25, dftsman., plant dept., Bell Telephone Company of Canada; Summers 1923 and 1926, constrn. work; 1927-28, demonstrator, hydraulics, Univ. of Toronto; 1928-35, asst. to chief engr., C. A. Dunham Co. Ltd.; at present, engr. in charge of space heating of the "Modutrol" divn., Minneapolis-Honeywell Regulator Co. Ltd., Toronto, Ont. (*St. 1926, Jr. 1930.*)

References: R. E. Smythe, R. W. Angus, W. S. Wilson, G. L. Wiggs, C. R. Young, W. B. Dunbar.

LEA—HARRY WINDSOR, of 1117 St. Matthew St., Montreal, Que., Born at Victoria, P.E.I., Nov. 2nd, 1898; Educ., B.Sc. (Civil), McGill Univ., 1931; 1916-19, overseas, C.E.F. and R.A.F.; 1920, instr'man., on townsite constrn. work, Kipewa Co., Kipewa, Que.; 1921, with H.E.P.C. of Ontario, on constrn. of Chippawa development, concrete inspr., etc.; 1922, asst. chief inspr., in charge of west divn., on paving and sidewalk constrn., Roads Dept., City of Montreal; 1922-27, asst. engr. of constrn., Dept. of Technical Service, City of Montreal; with R. S. and W. S. Lea, Consltg. Engrs., at various times during holidays, etc., on calculations in connection with design and cost of hydro-electric plants, and water and sewerage systems; 1928-29, with A. D. Swan, M.E.I.C., Consltg., Engr., as res. engr. on constrn. of new hbr. works at Chicoutimi; 1930 (summer), with Power Corporation of Canada, in charge of hydrographic survey for location of ship channel to quarry site on Georgian Bay (2 mos.). R. S. and W. S. Lea on hydraulic investigations and preparation of reports on hydro-electric power projects (2 mos.); 1931 to date, with Montreal Sewers Commission as designing engr. as to capacity and strength of various trunk and intercepting sewers, also design and layout of control structures of various types, sewage pumping plants and sewage treatment plant. (*Jr. 1924.*)

References: G. R. MacLeod, H. M. Scott, R. E. Jamieson, J. B. Challies, A. C. D. Blanchard, R. DeL. French.

MacNICOL—NICOL, of 333 Lonsdale Road, Forest Hill Village, Ont., Born at Barrie, Ont., May 18th, 1898; Educ., B.A.Sc., Univ. of Toronto, 1919; 1917 (3 mos.), rodman, Speight & Van Nostrand, Toronto; 1918 (5 mos.), dredge inspr., Canadian Stewart Co., Toronto; 1919-20, municipal engrg., Morris Knowles Co. Ltd., Windsor, Ont.; 1920 (6 mos.), struct'l. design, Smith, Hinchman & Grylls, Detroit; 1920-21, valuation work, Grand Trunk Western Lines, Detroit; 1921-23, municipal engrg., James, Proctor & Redfern, Toronto; 1923-31, township engr., Etobicoke Township, Islington, Ont.; 1931 to date, works commissioner, Forest Hill Village, Ont., having complete charge of engineering in two latter positions. (*St. 1918, Jr. 1923.*)

References: E. M. Proctor, W. B. Redfern, E. L. Cousins, W. E. Bonn, R. E. Smythe, A. E. Berry, A. E. K. Bunnell.

McGILLIS—LESTER, of Valleyfield, Que., Born at Lancaster, Ont., Apr. 27th, 1899; Educ., B.Sc. (E.E.), McGill Univ., 1924; 1919-20, ap'tice electrician, Northern Electric Co.; (summer) 1923, on transmission line erection, Shawinigan Engrg. Co.; 1924-25, electrician on substation and power house constrn., also elect'l. mtce., Hollinger Cons. Gold Mines; 1925-27, in charge of substation mtce. and erection, Rio de Janeiro Tramway Light & Power Co.; 1927-28, res. engr., at Parahybra plant. Responsible for operation of power house, dams, canals, etc.; Brazilian Hydro-Electric Co.; 1928 to date, with the Shawinigan Water and Power Co., first as supt. of North Shore Power Company, then asst. divn. mgr., and at present, mgr., Beauharnois Division. (*St. 1922, Jr. 1928.*)

References: J. H. Fregeau, B. Grandmont, C. V. Christie, G. A. Wallace, R. E. Heartz, J. A. McCrory.

THOMPSON—WILLIAM LENNOX, of Montreal, Que., Born at Dorchester, Ont., May 13th, 1902; Educ., B.A.Sc., Univ. of Toronto, 1927; 1926, with Fraser Brace Co. Ltd., International paper mill constrn., Gatineau, Que.; 1927-29, Bailey Meter Co., Cleveland, Ohio. Research development work. Supervision of erection and adjustment, Bailey control systems in central stations, Cleveland, Detroit and Boston; 1929 to date, sales-service engr., Bailey Meter Co. Ltd., Montreal. Quotations and sales contact; design and supervision of manufacture, installn. and adjustment of metering and control applications. Assisting and in charge of acceptance tests in connection with boilers, stokers, fuel and other auxiliary power plant equipment. (*St. 1923, Jr. 1929.*)

References: F. S. B. Heward, T. R. Loudon, F. A. Combe, R. E. MacAfee, J. H. Parkin, L. H. Birkett.

VAN KOUGHNET—EDWARD MATTHEW, of 157 Notre Dame St., St. Lambert, Que., Born at Buffalo, N.Y., Feb. 21st, 1902; Educ., Grad., R.M.C., 1922. 1922-23, McGill Univ.; 1923-24, Steel Co. of Canada, Hamilton, production of pig iron and hearth steel; 1924-25, Bell Telephone Co. of Canada, Montreal, outside plant survey; 1925-26, Caron Bros., Montreal, gasoline and electric power plants; 1926-28, Shawinigan Water & Power Co., transitman on trans. line layouts, i/c survey party on Mattawin River, hydraulic studies, etc.; 1928-29, Canadian General and Finance Co. Ltd., Toronto, and Sao Paulo Tramways, Sao Paulo, Brazil, trans. line studies, sr. asst. to res. engr. on constrn. of Rio Grande dam, Brazil; 1929-30, with the late F. B. Brown, M.E.I.C., consltg. engr., Montreal, i/c trans line estimates Beauharnois 220 k.v. line, hydraulic studies, estimates; 1930-32, Montreal Light, Heat & Power Cons., Montreal, design, estimates, and constrn. of high voltage trans. lines. (*St. 1922, Jr. 1928.*)

References: L. L. O'Sullivan, H. Milliken, J. A. McCrory, C. R. Lindsey, S. S. Colle, F. S. B. Heward.

VARLEY—PERCY, of 2384 Leclaire St., Montreal, Que., Born at Leeds, Yorks, England, Oct. 11th, 1900; Educ., Has passed E.I.C. Examinations under Schedules "B," 1932, and "C" (For admission as A.M.), 1933; 1915-21, with Canadian Vickers, Ltd., naval elect'l. dfting, 4 years, ap'ticeship, 2 years, dftsman., design and detailing installns. and equipment; 1922-23, mechl. dfting., refrigerating plant layouts and detailing ammonia compressors, Linde Canadian Refrigeration Co. Ltd.; 1923-24, locomotive dfting., design and detail of locomotive boilers, Montreal Locomotive Works Ltd.; 1924-26, archtl. dfting., Canadian Benedict Stone Co. Ltd.; 1926-28, locomotive dfting, standardizing locomotive parts, C.N.R.; Sept. 1928 to date, with Canadian Industries Limited, first year at Sandwich, Ont., as asst. engr. and dftsman., and at present, elect'l. dftsman., in charge of elect'l. plant layouts and design, Montreal. (*Jr. 1932.*)

References: L. de B. McCrady, I. R. Tait, H. C. Karn, A. B. McEwen, C. H. Jackson, E. B. Jubien.

FOR TRANSFER FROM THE CLASS OF STUDENT

BOSTOCK—WILLIAM NORMAN, of Esquimalt, B.C., Born at Monte Creek, B.C., Nov. 12th, 1903; Educ., B.Sc. (Civil), McGill Univ., 1925. (Grad., R.M.C.); 1927-28, asst. on Dom. Govt. survey party; 1930-31, Lieut., and 1931 to date, Capt., Royal Canadian Engrs., 1932-34, Geographical Section, General Staff, and 1934-35, Directorate of Engineer Services. (*St. 1925.*)

References: E. J. C. Schmidlin, G. R. Turner, C. R. S. Stein, E. L. M. Burns, D. Barry, W. L. Laurie, J. A. Wilson.

GODWIN—HAROLD BRANDON, of Camp Borden, Ont., Born at Westmount, Que., Apr. 24th, 1907; Educ., B.Sc., McGill Univ., 1928; 1923-24, North Shore Power Co.; 1925-26-27 (4 mos. each), Shawinigan Engrg. Co.; 1928 (4 mos.), Can. Gen. Elec. Co., Toronto; 1930-31, engrg. divn., R.C.A.F.; 1931-32, test flight, Ottawa Air Station; 1933-35, signals officer, R.C.A.F.; at present, Flight-Lieut., in charge of Signal Section, School of Army Co-operation, Camp Borden, Ont. (*St. 1925.*)

References: A. Ferrier, D. C. M. Hume, E. W. Stedman, C. V. Christie.

EMPLOYMENT SERVICE BUREAU

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CHEMICAL ENGINEER, for a large organization, with five to ten years operating experience in heavy inorganic chemical processes. An opportunity for a capable man. Apply giving full information regarding experience to Box No. 1177-V.

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Situations Wanted

SALES ENGINEER, S.E.I.C.; B.SC. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

Situations Wanted

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, Univ. Grad. 1928. Two years Students' apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660 W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

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Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), O.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, B.SC. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.SC. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.SC., '25, JR.E.I.C., P.E..Q, married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

Situations Wanted

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

Situations Wanted

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

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CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

COMBUSTION ENGINEER, A.M.E.I.C., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

CIVIL ENGINEER, B.Sc. '29, Jr.E.I.C., age 29, single. Experience in all types of surveying including use of aerial photographs. Three years on hydro-electric power development in field and office. Instrumentman on concrete road construction. Location immaterial. Apply to Box No. 1254-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '29). Age 28. Six years experience in automobile office and plant; two years as supervisor of inspection in body assembly. Good understanding of modern business methods applied to manufacturing. Desires position with production department of smaller Ontario industry. Good references. Interviews anywhere in central Ontario Apply to Box No. 1270-W.

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.Sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, Diplomas from Mtl. Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance. Present location Montreal. Available at once. Apply to Box No. 1326-W.

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Timber for Structural Use

Its Design, Working Stresses and Preservative Treatment

W. H. Greene, M.E.I.C.,
Chief Engineer, Canada Creosoting Company, Toronto, Ont.

Paper presented before the Calgary Branch of The Engineering Institute of Canada.

Wood preservation can be defined as the art of protecting structural timber from destructive agents, the most common of which are decay, insects, marine borers, mechanical abrasion and fire.

In the three prairie provinces, luckily, one is not concerned with insects or marine borers, therefore they will not be referred to except to state that their destructiveness can be prevented for many decades by creosoting.

Actual examples of untreated piling have been found being destroyed by teredo in ten months, and by limnoria in less than one year. In the same water creosoted piling was still sound after thirty to forty years. This is illustrated in the case of the Santa Monica long wharf which was built in 1891. Changes in freighters made the wharf obsolete, so between 1916 and 1921 it was dismantled. The creosoted piles and timbers, after more than twenty-five years service in water abounding with marine borers, were salvaged and re-driven and are still in service and still sound.

In the prairie provinces, the greatest enemy, after timber has been built into a structure, is decay which is caused by a low form of plant life known as fungi. The spores or reproduction bodies of the fungi are blown about by the wind and find lodgment on the surface or in cracks in the timber. They are very tenacious of life, can remain dormant for long periods of time and then germinate and grow. When fungi starts to grow they send out mycelia (minute roots) which penetrate into the sound wood. By the secretion of enzymes or ferments by these mycelia, the wood fibre is dissolved and its substance serves as food for the fungus. All fungi do not possess the same capacity to cause decay, it is only those forms which vigorously attack cellulose and lignin that affect the durability of timber to any serious degree. But give them a favourable temperature, and proper moisture and air supply and decay will proceed rapidly.

Preservative processes by injecting into and impregnating the wood with poisonous chemicals cause these enemies to commit suicide as soon as they attempt to gain nutrition. Thus decay and destruction is prevented.

Hundreds of chemicals and compounds have been advocated and tested for the preservation of wood from decay but only a few of them possess the necessary qualifications. A preservative must have the following qualities:

1. Toxic qualities that will positively kill all organisms that are destructive to wood. A chemical can be extremely poisonous to some and not affect others.
2. The chemical must have ability to penetrate the wood.
3. It must not affect the strength of the wood.
4. It must not corrode metal because the failure of the fastenings such as bolts, spikes, etc., used would destroy the structure even though the timbers remained sound. This qualification eliminates many chemicals that otherwise are efficient preservatives.
5. It must possess durability—that is, it must not evaporate, wash or leach out, or otherwise be lost for a long period of time.
6. The chemical must be reasonable in cost, safe to handle and readily available in large quantities.

To date, there are only two chemicals that have proved themselves, in accordance with these qualifications, by the test of time and exposure and these are creosote oil and zinc chloride.

Creosote oil is the best preservative discovered to date. It is reasonable in price, has a high toxic value and will positively kill all plant and insect enemies of wood, can be uniformly and effectively injected into any species of wood and exceeds all other chemicals in durability whether exposed to tropic or arctic temperatures, alkali or acid soils, fresh, stagnant, or salt water, wind and weather. It has no deleterious action on iron, steel or any other metal, in fact it will protect metals from corrosion.

Zinc chloride, while not suited to as many varied conditions of exposure as creosote oil, is an efficient and valuable preservative. Wood impregnated with it cannot be used in running water because the salt is water soluble and will leach out. Perhaps its most valuable asset is that it makes wood highly resistant to fire—the wood will char but will not readily ignite and burn. Wood treated with this preservative is odourless and can be painted the same as untreated wood which makes it suitable for use in buildings.

A modern wood preserving plant with a medium capacity will cost, for land, buildings and equipment, from $500,000 upwards and then half as much more for stocks of preservatives, lumber, etc. When operating to capacity it will employ about two hundred men, so such a plant is an asset to any community.

The plant will consist of a retort house containing two or more cylinders (from about 130 to 160 feet in length and 7 feet in diameter) made of heavy steel plates, equipped with heating coils, and complete with Rueping, measuring and storage tanks, vacuum and pressure pumps, condensing

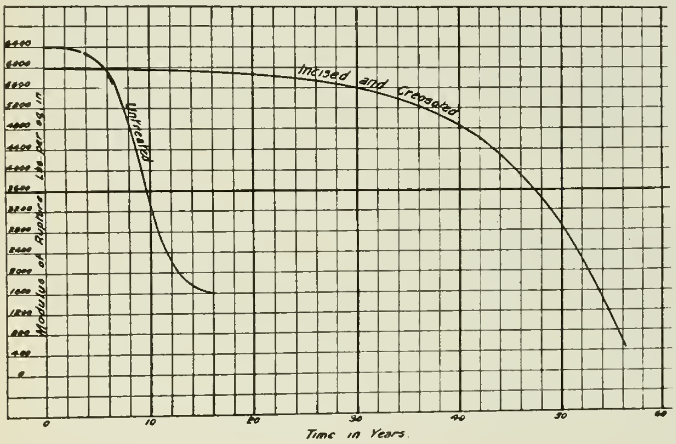

Fig. 1.

and vapour drums, recording gauges, etc. Then there must be butt-treating plant complete with dipping and storage tanks, pumps, derrick, scaffolds, skids, inciser, live rolls, heaters, etc.; boiler plant; framing plant (planer, inciser, borer, saws, etc.); boring, adzing and incising plant, gasoline dinkeys; locomotive crane; cylinder buggies; and several miles of both standard and narrow gauge tracks.

The actual preservative process is more or less the same for any chemical used. The timber is loaded on the cylinder cars, narrow wooden strips being placed between the rows thus leaving a space between each piece of timber so that the preservative can reach every surface. The cars are then run into the cylinder and the end is sealed. Then the moisture and sap are extracted either by boiling in the creosote oil under a vacuum, or, with some woods, by means of moist steam. If the Rueping empty-cell process (the one almost always used except where the timber will be in salt water) is to be used the cylinder is then emptied of oil and air pumped in and compressed. Without releasing the air pressure, the preservative at a temperature of from 180 to 220 degrees F., depending on the species of wood, is pumped in and the pressure increased and maintained until sufficient preservative has been forced into the wood. More preservative than is to be left in the wood is always put in. The cylinder is then emptied of oil and a vacuum pulled to remove the excess oil. An expansion bath (the timber is boiled in creosote oil at atmospheric pressure) is usually given before the vacuum to dry the surface of the wood.

The difference between the "full-cell" and "empty-cell" processes is that in the former the cell-walls and the cells themselves are left full of oil while in the latter all free oil is removed from the cells and only the cell-walls left saturated with creosote.

In using zinc chloride this salt is first dissolved in water, then the solution is injected into the wood in a similar manner by pressure and heat and the water then evaporates and leaves the cells filled with the dry salt.

In general, when wood is preservatively treated the chemical does not impregnate the timber through and through, but the unimpregnated core is amply protected. Maximum benefit and economy are obtained when the timbers are framed before being treated and in the vast majority of cases this is entirely practicable. Where cutting and boring on the job must be done care must be taken to protect any exposed raw wood—it is feasible to do this.

The treating process will also sterilize the wood and destroy the organisms of incipient decay that may have obtained a foothold even during logging operations.

The loss of creosote from wood follows a well established law which applies to loss by both evaporation and leaching. By means of this law it is possible to predict with considerable accuracy the probable life of such material in any installation. Tests, consisting of the extraction of creosote oil remaining in the timbers of different types of structures after they had been in service for from forty to fifty years, show that there has been little or no loss of the preservative up to that time. As the most volatile fractions would be lost first and as these comprise less than 25 per cent of creosote oil it will be seen that the rate of loss per annum will decrease as time goes on.

The Lake Pontchartrain trestle, near New Orleans, built during 1882-83, was the first treated timber bridge on this continent. It is about six miles in length, the timbers and piles being treated with creosote oil.

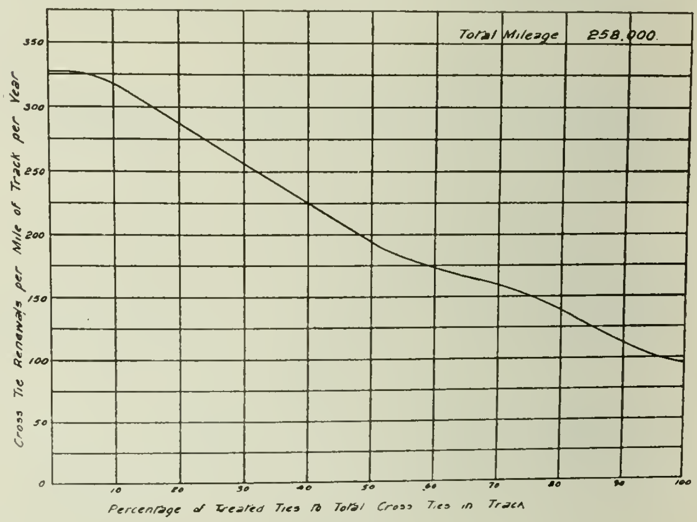

Fig. 2.

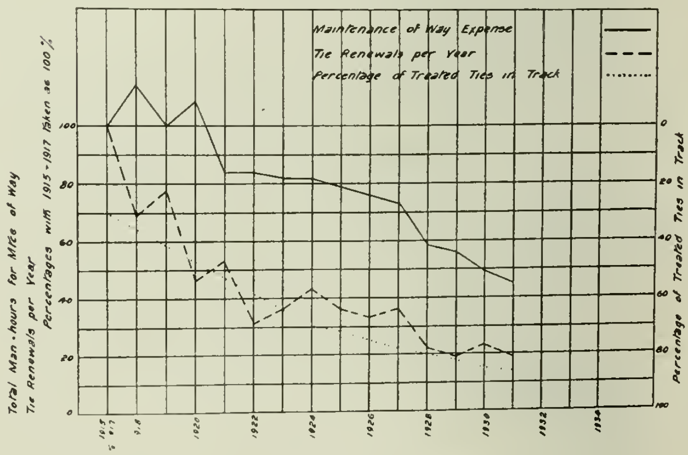

Fig. 3.

This bridge is still in service and the United States Commerce Commission places its useful life at seventy years or more. Some five years ago tests were carried out at Tulane University, New Orleans, which showed that the original strength of the timbers had not been reduced more than 6½ per cent which is negligible considering the factor of safety used in timber design.

The ability of the two present-day recognized preservatives, creosote oil and zinc chloride, to resist decay and retain the original strength of the wood is of the greatest economic importance—that ability has changed untreated timber structures, rightly classed as "temporary construction," into "permanent construction."

There is a further economic advantage that may be secured by using timber that is treated with creosote oil

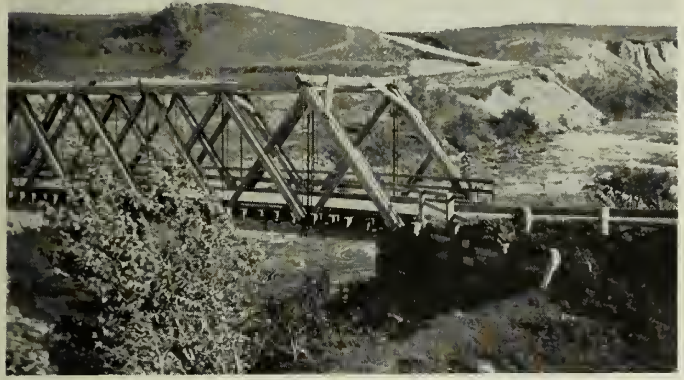

Fig. 4—Wooden Bridge Built of Untreated Timber.

and is thus made waterproof. It concerns the working stresses used in designing any structure.

When a timber structure is designed the working stresses used are only a fractional part of the actual strength of the new timber. In the determination of working stresses both the strength at the elastic limit and the breaking strength have been considered but as the former is more variable and less definite than the latter, the ultimate or breaking strength is taken as the more dependable basis for the determination of safe working stresses.

Modern timber technology considers it good practice to take the fibre stress at the elastic limit at not more than 56 per cent of the modulus of rupture and the working stress at 60 per cent of the fibre stress at the elastic limit. Or in other words the working stress is 39 per cent of the modulus of rupture.

The following figures are for coast type Douglas fir—those for other species of wood will be different but the ratios will remain approximately the same.

The modulus of rupture for coast type Douglas fir in "green condition" is 8,100 pounds per square inch but if in "air-dry condition" it is 14,800 pounds, or 83 per cent stronger.

First, consider a structure of untreated timber. The recommended working stresses are based on "green condition" and these will also be reduced to provide for considerable loss of strength due to decay. The initial strength of the wood will be much greater than that used in arriving at the working stresses and this is necessary because immediately after being built into the structure, or even before it, if the timber is kept in storage for some time, exposure and decay will start to weaken the wood. It would be entirely feasible to use seasoned timber but nothing would be gained because the timber would soon absorb moisture from the air, rain and melting snow and return to the "green, or unseasoned, condition." As a matter of fact the use of seasoned timber would be a mistake and detrimental because if, after being seasoned, wood reabsorbs moisture to above the "fibre saturation point" its strength will be less than the original green strength. As untreated timber in outside locations will nearly always have a moisture content, for part of the year at least, above the "fibre saturation point" it would be unsafe to use working stresses higher than those for green timber.

However, this is not the case with creosoted timber because the creosote oil waterproofs the timber and for structures not continuously, or nearly so, immersed in water will keep the moisture content at, or below, the "fibre saturation point," This has been proved by tests made by the Canadian Forest Products Laboratories. In making comparative strength tests on creosoted versus untreated ties they first submerged the treated ties in water for seven months and only raised the moisture content less than one per cent. It would be impossible for creosoted timber in service, and as specified not constantly submerged, to absorb even this small amount of water—so higher working stresses can safely be used, based on "air dry condition." The use of these higher working stresses simply means that a creosoted timber structure can be built with timber of smaller dimensions and this saving in cost will assist in paying for the creosoting. Also the creosoted structure will last from 3 to 5 times as long (see Fig. 1.)

Figure 1 is for timber having a safe working stress of 1,400 pounds per square inch and the condition of exposure is for a bridge in western Canada. The modulus of rupture cannot safely fall below 3,600 pounds and the untreated timber is reduced to that in just under ten years while the creosoted timber takes forty-seven years.

Figure 2 shows the average annual tie renewals per mile of track for the railways in Canada and the United States—it is complied from the average figures for 258,000 miles of track. The saving per year for each tie that does not have to be renewed varies widely in different localities

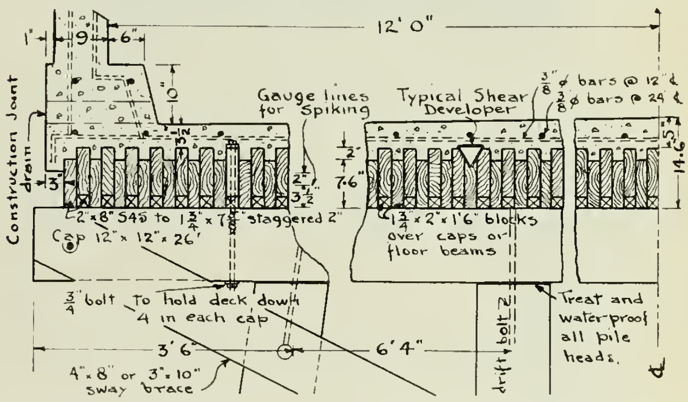

Fig. 5—Timber Substructure and Stringer System Supporting Concrete Deck.

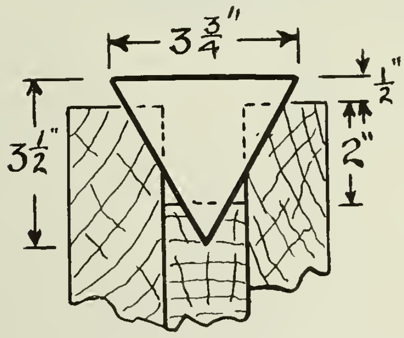

Fig. 6—Shear Developer.

but will average $1.37 per tie in place. There are very nearly 3,000 ties in a mile of track so the saving per mile will be $4,100 or more.

Wooden bridges in some form or other have been used for thousands of years. These bridges, being built of untreated timber and thus being more or less "temporary" in character, were strictly utilitarian in design and construction. Usually there was no effort made to erect an architecturally pleasing structure. They were low in cost, easy to erect, carried the traffic safely and thus sufficed for the need at that time.

But now that preservative treatment has raised timber construction into the "permanent" classification more attention is being given to the appearance of the finished structure.

Fig. 7—Composite Type Bridge of Oregon State Highway Department.

In a highway system anywhere from 60 to 90 per cent of the bridges will have a span of less than 40 feet so the development of an artistic type of reasonable cost is of interest to all highway departments.

Up until little over a year ago a choice had to be made between:

1. Creosoted pile or framed bent trestle with creosoted timber superstructure.
2. Creosoted pile trestle with steel I-beam stringers and concrete deck.
3. Reinforced concrete structure.

There is very little difference in cost between Nos. 2 and 3, each being about two to two and a half times higher in cost than No. 1.

The new composite slab or beam types, wherein creosoted timber and concrete are made to work in conjunction, provide an intermediate type of reasonable first cost, beauty of appearance and long life.

Essentially, the type consists of a creosoted timber substructure and stringer system with integrally supported concrete deck. For spans up to 30 feet a continuous timber deck is used, this being built up of vertical laminations of 2-inch plank spiked or bolted together. The upper edges of alternate laminations are raised 2 inches thus forming longitudinal grooves. Into these longitudinal grooves are driven thin triangular steel plates called shear developers, which mortise into the corners of the raised laminations as well as into the top of the intermediate depressed ones. Three-sided support from the wood is thus secured for these keys, the top of which project into the concrete deck.

For spans from about 24 to 40 feet an individual stringer system is used. It will be noted that the two types are interchangeable for spans of between 25 and 30 feet, the decision depending on which costs the least. In this type the shear developers are usually of pipe, thus combining strength and bearing area with lightness, and the tops of the stringers are usually dapped.

The laminated type does not require any forms for the concrete deck as the wood portion alone develops adequate strength to support loads which may be placed on the deck during construction. A concrete paver could be run over this deck and thus do away with transportation of the concrete in buggies.

Figure 7 shows one of fifty composite type bridges built or under construction by the Oregon State Highway Department.

The sub-structure possesses all the economic advantages of creosoted timber but the appearance when compared with standard designs of the past is so vastly improved as to be almost unrecognizable. This class of architectural design does not add much to the cost and the slight increase is justified in many structures where the aesthetics of the site must be considered and conserved.

Design of Continuous Reinforced Concrete Arches by the Fixed Point Method

For the Cathedral, at Valleyfield, Que.

E. Nenniger, A.M.E.I.C.,
Associate, Arthur Surveyer and Co., Consulting Engineers, Montreal.

Part II*

Live Load Moments.

As far as the bending moments due to the live loads are concerned, it is advisable to determine the moments separately for each member, so that any combination of loading can be analyzed at the end, by adding the different results together to obtain the most unfavourable stresses at any point of the frame. The moments due to the live loads on beam 2, brackets 4 and brackets 5 present no difficulty, as they are simply proportional to the dead load moments in each particular case as computed above.

In the case of the live load (wind load) applied on the arch, it is necessary to subdivide the calculations into two stages in order to account for the side sway of the frame. It is assumed that a temporary force is applied at point B of the frame to prevent side sway, and all moments due to wind are determined in the usual manner. The magnitude of this temporary force is then obtained with the help of the bending moments. This force is then reversed, and applied at point B. The bending moment in the frame due to this force is added to the result of the computation under stage one. The following gives an example of the procedure as applied to the frame of the Valleyfield cathedral.

*Part I appeared in the August, 1935 issue of The Engineering Journal.

Moments due to wind load on Arch 3. (Figure 20.)

The wind load acting against the frame was taken as 30 pounds per square foot of wall area, and 15 pounds per square foot applied on the roof area measured perpendicular to the slope of the roof. The resulting wind loads acting against the frame at each point of the arch are shown in Fig. 15, together with the reactions at both supports of the principal system or the frame made statically determinate by assuming one of the supports resting on a roller bearing (in this case support B').

Table X gives in detail the calculations for the M^0 values for each point of the frame. In this case, the values M^0 represent the bending moments due to the wind loads applied on the principal system. The values used in this table are:

H_B = 28,490 pounds = horizontal reaction at joint B

V_B = 19,460 pounds = vertical reaction at joint B

$V_{B'}$ = 26,650 pounds = vertical reaction at joint B'

W_1, W_2, W_3, windloads at point 1, 2 and 3 respectively.

Table XI shows the values necessary to obtain the horizontal thrust in the arch and the end moments at the joints B and B' due to the wind loads.

$$H = \frac{1{,}159{,}628\,000}{114{,}312} = 10{,}150 \text{ pounds}$$

$$\varphi^a = \frac{1}{52} \times 810{,}985{,}380 - \frac{10{,}150}{2} \times 2 \times 976.26 = +5{,}690.000$$

$$\varphi^b = \frac{265{,}600{,}700}{52} - \frac{10{,}150}{2} \times 2 \times 976.26 = -4{,}800{,}000$$

With the above values, both items k^a and k^b can now be determined and they are obviously no more identical than in the former cases, as the external loading is not symmetrical.

$$k^a = -\frac{\varphi^b}{\beta} = -\frac{-4{,}800{,}000}{-4.535} = -1{,}057{,}500 \text{ foot-pounds}$$

$$k^b = -\frac{\varphi^a}{\beta} = -\frac{+5{,}690{,}000}{-4.535} = +1{,}255{,}000 \text{ foot-pounds}$$

The graphical method to obtain the end moments is as follows: Plot value k^a from joint B upwards in the scale as adopted for the moments. Draw a line through joint B' until it intersects a perpendicular drawn through the right hand fixed point of the arch, thus cutting off the value S^b. Proceed in a similar manner with the value k^b, which, however, has to be plotted from joint B' downwards, as it is a positive value. By drawing a line from k^b through joint B, the distance S^a is obtained at the left hand fixed point of the arch. Analytically S^a and S^b are,

$$S^a = -\frac{56.10}{52} \times 1{,}255{,}000 = -1{,}355{,}000 \text{ foot-pounds}$$

$$S^b = -\frac{56.10}{52} \times -1{,}057{,}500 = +1{,}142{,}000 \text{ foot-pounds}$$

Both end moments are now easily obtained by drawing a line from S^a to S^b.

This line cuts off the magnitude of both moments $M_3{}^B$ and $M_3{}^{B'}$ above joint B and below joint B'. Analytically these moments amount to:

$$M_3{}^B = -\frac{1.355000}{89.20} \times 33.10 = -503{,}000 \text{ foot-pounds}$$

$$M_3{}^{B'} = \frac{1.142000}{75.00} \times 18.90 = +288{,}000 \text{ foot-pounds}$$

TABLE X

Point	$H_B \times y$	W_{12} to W_{20}	W_{21} to W_{27}	$V_B \times x$	M^0 in ft.-lbs.
1	14245				= 14255
2	56980				= 56980
3	113960				= 113960
4	170940				= 170940
5	240000				= 240000
6	320000				= 320000
7	401000				= 401000
8	482000				= 482000
9	562000				= 562000
10	643000				= 643000
11	719000				= 719000
12	796000	− (0 6440 × 2.69) = − 17320			= 778680
13	878000	− (17320 + 7880 × 2.87) = − 39920			= 838080
14	959000	− (33920 + 9320 × 2.88) = − 66770			= 892230
15	1040000	− (66770 + 10760 × 2.87) = − 97650			= 942350
16	1121000	− (97650 + 12200 × 2.82) = − 132050		− 447	= 988503
17	1200000	− (132050 + 13600 × 2.76) = − 169600		− 4075	= 1026325
18	1277000	− (169600 + 15000 × 2.75) = − 210850		− 11300	= 1054850
19	1355000	− (210850 + 16400 × 2.70) = − 255150		− 22150	= 1077700
20	1456000	− (255150 + 17800 × 3.60) = − 319200		− 42300	= 1094500
21	1580000	− 20220 × 20.24 = − 409500		− 77000	= 1093500
22	1700000	− 20220 × 24.40 = − 493500	− (0 + 1785 × 4.68) = − 8360	− 121500	= 1076640
23	1812000	− 20220 × 28.27 = − 571500	− (8360 + 2995 × 4.68) = − 22360	− 175000	= 1043140
24	1910000	− 20220 × 31.80 = − 643000	− (22360 + 4205 × 4.73) = − 42260	− 236500	= 988240
25	2000000	− 20220 × 34.94 = − 707000	− (42260 + 5415 × 4.72) = − 67780	− 306000	= 919220
26	2075000	− 20220 × 37.64 = − 761500	− (67780 + 6625 × 4.65) = − 98580	− 382000	= 832920
27	2141000	− 20220 × 39.88 = − 806000	− (98580 + 7775 × 4.40) = − 132780	− 463500	= 738720
27′	2141000	− 806000	− (132780 + 8925 × 2.875) = − 158430	− 548000	= 628570
26′	2075000	− 761500	− (132780 + 8925 × 3.918) = − 167730	− 629500	= 516270
25′	2000000	− 707000	− (132780 + 8925 × 4.36) = − 171680	− 702320	= 419000
		+ $V_{B'} \times [l - x]$			
25′		= 26650 × 15.73 =			= 419000
24′		= 26650 × 12.168 =			= 324000
23′		= 26650 × 8.993 =			= 239500
22′		= 26650 × 6.245 =			= 166500
21′		= 26650 × 3.965 =			= 105600
20′		= 26650 × 2.1809 =			= 58000
19′		= 26650 × 1.1365 =			= 30250
18′		= 26650 × 0.5811 =			= 15500
17′		= 26650 × 0.2095 =			= 5580
16′		= 26650 × 0.0233 =			= 620
15′ to B'		= 26650 × 0.000 =			= 0

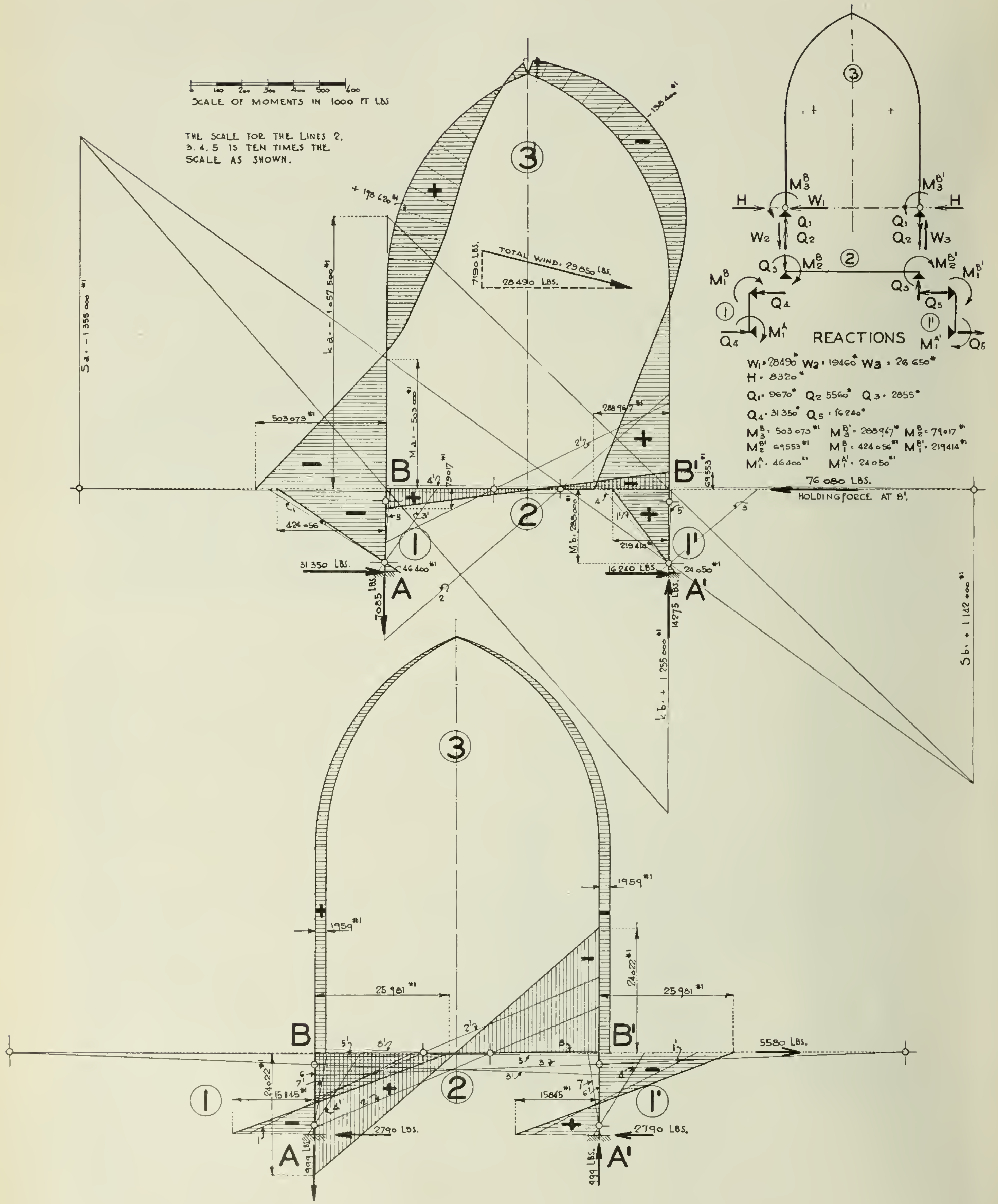

Fig. 20 (above). Fig. 21 (below).

Table XI

Point	Left Side of Arch M^0	$M^0 yw$	$M^0 [l-x] w$	M^0xw	Right Side of Arch M^0	M^0yw	$M^0 [l-x] w$	M^0xw
1	14245	0	0	0	0	0	0	0
2	56980	34200	888000	0	0	0	0	0
3	113960	159000	2069000	0	0	0	0	0
4	170940	420000	3815000	0	0	0	0	0
5	240000	1272000	7860000	0	0	0	0	0
6	320000	2268000	10475000	0	0	0	0	0
7	401000	3560000	13140000	0	0	0	0	0
8	482000	5135000	15770000	0	0	0	0	0
9	562000	7000000	18400000	0	0	0	0	0
10	643000	9140000	21050000	0	0	0	0	0
11	719000	0	0	0	0	0	0	0
12	778680	13900000	25900000	0	0	0	0	0
13	838080	16500000	27900000	0	0	0	0	0
14	892230	19180000	29700000	0	0	0	0	0
15	942350	22000000	31320000	0	0	0	0	0
16	988500	22800000	30050000	12850	620	14300	8	18850
17	1026325	23700000	29120000	118000	5580	129000	642	158500
18	1054850	20000000	22920000	259000	15500	294500	3800	338500
19	1077700	15550000	16640000	372000	30259	437000	10430	467000
20	1094500	37400000	36400000	1594000	58000	1985000	84500	1932000
21	1093500	75800000	65600000	5420000	105600	7330000	523000	6340000
22	1076640	101650000	78000000	10640000	166500	15740000	1646000	12060000
23	1043140	105200000	71000000	14850000	239500	24180000	3410000	16300000
24	988240	105000000	62300000	19040000	324000	34450000	6240000	20420000
25	919220	102000000	52700000	22900000	419000	46550000	10440000	24020000
26	832920	96200000	42650000	25900000	516270	59650000	16360000	26500000
27	738720	88000000	32900000	27820000	628570	75000000	23700000	28020000
		893868200	748567000	128925850		265759800	62418380	136574850
		265759800	62418380	136574850				
		1159628000	810985380	265500700				

These moments have to be distributed around the frame in the ordinary way to obtain the final values at both joints B and B'.

Table XII

Distribution of end moments M_3B and M_3B'.

		M_1B	M_2B	M_3B	M_1B'	M_2B'	M_3B'
M_3B	503000 × 0.884	−444600		−503000			
	503000 × 0.116		+58400				
	58400 × 19.90					−36200	
	32.10						
	36200 × 0.962				−34825		
	36200 × 0.038						+ 1375
	1375 × 56.10			+ 714			
	108.10						
	714 × 0.884	+ 631					
	714 × 0.116		− 83				
M_3B'	288000 × 1.00						+288000
	288000 × 0.884				+254600		
	288000 × 0.116					−33400	
	33400 × 19.90						
	32.10		+20700				
	20700 × 0.962	+ 19913					
	20700 × 0.038			− 787			
	787 × 56.10						
	108.10						− 408
	408 × 0.884				− 361		
	408 × 0.116					+ 47	
		−424056	+79017	−503073	+219414	−69553	+288967
		79017			69553		
		503073			288967		

The final horizontal thrust in the arch is

$$H = 10,150 + \frac{1}{2} 0.01708 (-503,073 + 288,967) = 8,320 \text{ pounds.}$$

The bending moments for every point of the arch due to the wind loads acting from the right to the left on the frame are shown in Table XIII.

Correction of moments for side sway. Stage II. (See Fig. 21.)

The temporary holding force supporting joint B to prevent side sway has to be determined first. For this purpose, it is assumed that the horizontal reactions acting from right to left are negative and the horizontal reactions acting from left to right positive. The reactions for every member of the frame due to the wind load moments are indicated in Fig. 20. The holding force is therefore.

Influence of arch 3 at B...........	−28,490 (W')	+8,320 (H)
Influence of arch 3 at B'..........	0	−8,320 (H)
Influence of beam 2...............	0	0
Influence of column 1 = − Q_4......	−31,350	0
Influence of column 1′ = − Q_5......	−16,240	0
Total holding force at B'.......	−76,080 pounds	0 pounds

Before proceeding any further, a preliminary verification of the moments and reactions should be made to see if the result of the calculations for the wind load moments for Stage I is correct. For this purpose, the three basic formulae are applied, namely:

1 = ΣH = 0 or the sum of all horizontal forces is equal to zero

2 = ΣV = 0 or the sum of all vertical forces is equal to zero

3 = ΣM = 0 or the sum of all moments around any pole is equal to zero.

The application of these formulae gives the following result:

(*a*) Horizontal forces.

Wind load	=	+ 28,490 pounds
Support A	=	+ 31,350 pounds
Support A'	=	+ 16,240 pounds
Support B'	=	− 76,080 pounds
ΣH	=	0000 pounds

(*b*) Vertical forces.

Wind load	−	7,190 pounds
Support A	−	7,085 pounds
Support A'	+	14,275 pounds
ΣV	=	0000 pounds.

Table XIII

Wind Load Moments Stage I

The moments at any point of the arch are:

$$M = -M^0 - \underbrace{503073 \times \frac{52-x}{52}}_{a} + \underbrace{288967 \times \frac{x}{52}}_{b} - \underbrace{8320\,y}_{c}$$

	Left Side					Right Side				
Point	$+M_0$	$-a$	$+b$	$-c$	M	$+M_0$	$-a$	$+b$	$-c$	M
0	0	− 503073	0	0	− 503093	0	0	+ 288967	− 0	+ 289209
1	14245	− 503000	0	− 4160	− 492915	0	0	+ 288900	− 4160	+ 285040
2	56980	− 503000	0	− 16640	− 462660	0	0	+ 288700	− 16640	+ 272360
3	113960	− 503000	0	− 33300	− 422340	0	0	+ 289000	− 33300	+ 255700
4	170940	− 503000	0	− 49900	− 381960	0	0	+ 289000	− 49900	+ 239100
5	240000	− 503000	0	− 70000	− 333000	0	0	+ 289000	− 70000	+ 219000
6	320000	− 503000	0	− 93600	− 276600	0	0	+ 289000	− 93600	+ 195400
7	401000	− 503000	0	− 117000	− 219000	0	0	+ 289000	− 117000	+ 172000
8	482000	− 503000	0	− 141000	− 162000	0	0	+ 289000	− 141000	+ 148000
9	562000	− 503000	0	− 164300	− 105300	0	0	+ 289000	− 164300	+ 124700
10	643000	− 503000	0	− 188000	− 48000	0	0	+ 289000	− 188000	+ 101000
11	719000	− 503000	0	− 210000	+ 6000	0	0	+ 289000	− 210000	+ 79000
12	778680	− 503000	0	− 232200	+ 43480	0	0	+ 289000	− 232200	+ 56800
13	838080	− 503000	0	− 256500	+ 78580	0	0	+ 289000	− 256500	+ 32500
14	892230	− 503000	0	− 280000	+ 109230	0	0	+ 289000	− 280000	+ 9000
15	942350	− 503000	0	− 304000	+ 135320	0	0	+ 289000	− 304000	− 15000
16	988500	− 502000	+ 130	− 327500	+ 159000	620	− 225	+ 289000	− 327500	− 38105
17	1026325	− 500500	+ 1165	− 351000	+ 175990	5580	− 2060	+ 288000	− 351000	− 57020
18	1054850	− 497500	+ 3230	− 373000	+ 187580	15500	− 5620	+ 286000	− 373000	− 77120
19	1077700	− 492000	+ 6320	− 396000	+ 196000	30250	− 10980	+ 283000	− 396000	− 93730
20	1094500	− 482000	+ 12120	− 426000	+ 198620	58000	− 21100	+ 277000	− 426000	− 112100
21	1093500	− 464000	+ 22050	− 462500	+ 189050	105600	− 38300	+ 267000	− 462500	− 128200
22	1076640	− 442500	+ 34700	− 497000	+ 171840	166500	− 60400	+ 254500	− 497000	− 137400
23	1043140	− 416000	+ 50000	− 530000	+ 147140	239500	− 86900	+ 239000	− 530000	− 138400
24	988240	− 385000	+ 67700	− 558000	+ 112940	324000	− 117600	+ 221200	− 558000	− 130400
25	919220	− 350500	+ 87500	− 585000	+ 71220	419000	− 152000	+ 201500	− 585000	− 116500
26	832920	− 313000	+ 109000	− 606000	+ 22920	516270	− 190000	+ 190000	− 606000	− 89730
27	738720	− 272500	+ 132500	− 626000	− 27280	628570	− 230000	+ 156600	− 626000	− 70830

(*c*) Moments around joint *B*.

Due to wind	= + 1385750	= 29450 × 47.00
Due to horizontal reaction at A	= − 470250	= 31350 × 15.00
Due to horizontal reaction at A^1	= − 243600	= 16240 × 15.00
Due to moment at A	= + 46400	
Due to moment at A^1	= + 24050	
Due to vertical reaction at A^1	= − 742350	= 14275 × 52.0
ΣM at joint B	= 0000	

In order to obtain the additional moments due to the holding force amounting to 76,080 pounds, it is assumed that the joints B' and B are displaced in the direction from left to right by an assumed amount of, say, one one-thousandth of one foot. Such a displacement of the joints B and B' causes an elastic deformation of both columns and therefore bending moments in both columns amounting to

$$M_1{}^B = \frac{E \times \Delta \times b_1}{l_1 \times \beta_1 [\, l_1 - a_1 - b_1 \,]} = \text{moment at joint } B \text{ of column 1}$$

$$= \frac{432{,}000{,}000 \times 0.001 \times 2.16}{15 \times 0.288 \times 11.36} = +\ 19{,}000 \text{ foot-pounds}$$

$M_1{}^{B'}$ = moment at joint B^1 of column 1′ $= -\ M_1{}^B$ due to symmetry

$$M_1{}^A = \frac{E \times \Delta \times a_1}{l_1 \times \beta_1 [\, l_1 - a_1 - b_1 \,]} = \text{moment at support } A \text{ of column 1}$$

$$= \frac{432{,}000{,}000 \times 0.001 \times 1.48}{15 \times 0.288 \times 11.36} = -\ 13{,}000 \text{ foot pounds}$$

$M_1{}^{A'}$ = moment at support A' of column 1′ $= +\ 13{,}000$ foot-pounds due to symmetry.

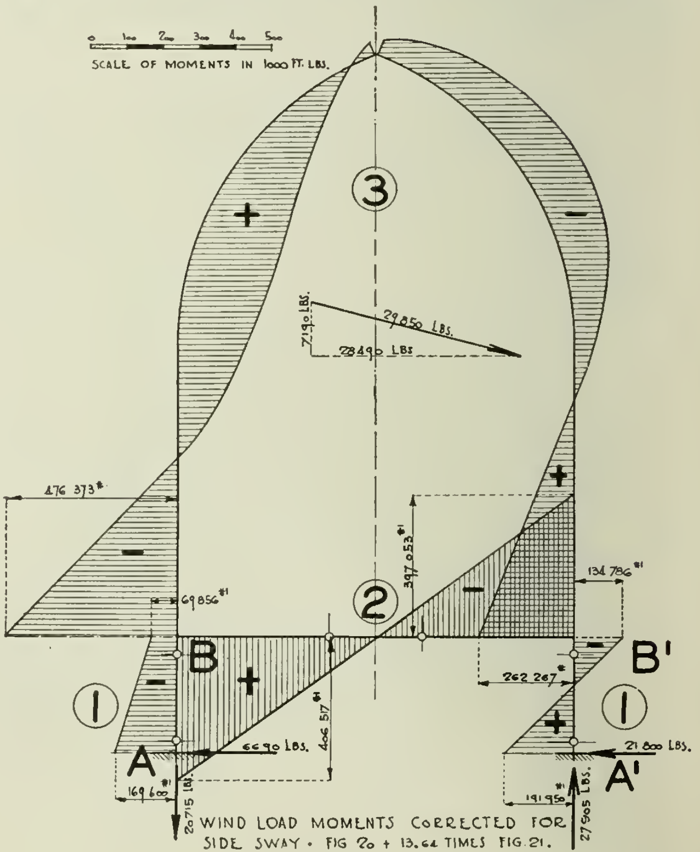

Fig. 22.

The moments $M_1{}^B$ and $M_1{}^{B'}$ have to be distributed around the frame in the usual manner. In Fig. 21 is shown the distribution of these moments by the graphical method. The following table indicates the analytical method.

Table XIV

	$M_1{}^B$	$M_2{}^B$	$M_3{}^B$	$M_1{}^{B'}$	$M_2{}^{B'}$	$M_3{}^{B'}$
19000 × 1.0 =	+19000					
19000 × 0.767 =		+14570				
19000 × 0.233 =			+4430			
14570 × $\frac{19.90}{32.10}$ =					− 9040	
9040 × 0.962 =				− 8697		
9040 × 0.038 =						+ 343
343 × $\frac{56.10}{108.10}$ =			+ 178			
178 × 0.884 =	+ 158					
178 × 0.116 =		− 20				
4430 × $\frac{56.10}{108.10}$ =						+2300
2300 × 0.884 =				+ 2033		
2300 × 0.116 =					− 267	
267 × $\frac{19.90}{32.10}$ =		+ 165				
165 × 0.962 =	+ 159					
165 × 0.038 =			− 6			
Moments due to Col. 1	+19317	+14715	+4602	− 6664	− 9307	+2643
Moments due to Col. 1′	+ 6664	+ 9307	−2643	−19317	−14715	−4602
	+25981	+24022	+1959	−25981	−24022	−1959
		+ 1959			− 1959	
		+25981			−25981	

Moments at joint A and A^1 = due to displacement = 13,000 foot-pounds

$$\text{due to } M^B = \frac{25{,}981}{13.52} \times 1.48 = \frac{2{,}845}{15{,}845} \text{ foot-pounds}$$

With these moments known, it is possible to obtain the force necessary to cause a displacement of joints B and B' of 1/1000 of one foot.

Horizontal thrust of arch = zero

$$\text{Thrust of column 1} = \frac{25{,}981 + 15{,}845}{15.00} = +\ 2{,}790 \text{ pounds}$$

Thrust of column 1′ = + 2,790 pounds

Total displacement force at B' + 5,580 pounds

The above result has to be multiplied by a factor of 76,080 ÷ 5,580 = 13.64 to obtain the final moments for Stage II. These moments due to side sway of the frame subjected to the wind loads are as follows:—

$$M_1{}^A = M_1{}^{A'} = 15{,}845 \times 13.64 = 216{,}000 \text{ foot-pounds}$$
$$M_1{}^B = M_1{}^{B'} = 25{,}981 \times 13.64 = 354{,}200 \text{ foot-pounds}$$
$$M_2{}^B = M_2{}^{B'} = 24{,}022 \times 13.64 = 327{,}500 \text{ foot-pounds}$$
$$M_3{}^B = M_3{}^{B'} = 1{,}959 \times 13.64 = 26{,}700 \text{ foot-pounds}$$

Vertical reaction at A or A'
= 999 × 13.64 = 13,630 pounds

Horizontal reaction at A or A'
= 2,790 × 13.64 = 38,040 pounds

The final moments in the frame due to wind loads, and taking into consideration the side sway, are obtained by adding together the results of Stage I and Stage II. These moments are shown in Fig. 22.

The final verification of the result shows that

(a) $\Sigma H = +\ 28{,}490 - 6{,}690 - 21{,}800 = 0$

(b) $\Sigma V = +\ 7{,}190 - 27{,}905 + 20{,}715 = 0$

(c) ΣM around point B

due to wind =	+1,385,750	foot-pounds
due to A' = 21,800 × 15 =	+ 327,000	foot-pounds
27,905 × 52 =	−1,451,100	foot-pounds
− 191,950 =	− 191,950	foot-pounds
due to A = 6,690 × 15 =	+ 100,350	foot-pounds
− 169,600 =	− 169,600	foot-pounds
M =	− 450	foot-pounds

The difference in the case of ΣM is only 450 foot-pounds which represents an error of only 0.025 per cent. Considering that all calculations are made by slide rule, it can be said that the result is satisfactory.

An examination of the diagrams showing the moments for Stage I, and the combination of Stages I-II, reveals the tremendous importance of correcting the bending moments due to side sway. It is possible, of course, that the ground floor slab which is anchored into the front wall has a somewhat restraining effect upon the frame, and reduces the moments due to side sway to a certain extent. The arches located close to the expansion joint, are, however free to move, and have to be dimensioned accordingly. It was found advisable, therefore, for the purpose of dimensioning the frame, to take both extreme cases into consideration and use those bending moments in combination with the corresponding thrusts whichever produced the higher stresses. It can also be seen how valuable the analysis of such a frame according to the fixed point method is, as the influence of side sway can be computed so easily, without much additional work.

The maximum moments for any point of the frame are now found by tabulating the following cases:

Case I no side sway. Moments due to dead loads of entire frame.
Live loads on beam 2, arch and brackets 4 and 5.

Case II with side sway. Moments due to dead loads of entire frame.
Live loads on beam 2, arch, and brackets 4 and 5.

The following table shows the moments for the above two cases. For this purpose, the live load moments for the beam and the brackets were taken directly in proportion to the moments due to dead loads on these members. All moments causing tension at the intrados of the arch were taken as positive and all moments causing tension at the bottom of beam 2, brackets 4 and 5 and at the inside face of the columns also as positive.

Table XV

Recapitulation of Dead Load and Live Load Moments.

Point	Total Dead Loads	L.L. 2 59.2 per cent of D.L.	L.L. 4 25½ per cent of D.L.	L.L. 5 50 per cent of D.L.	Wind no side sway left half	Wind no side sway right half	Wind with side sway left half	Wind with side sway right half
$M_1{}^A$	− 5247	+ 34000	− 9130	− 325	+ 46500	− 24000	−169600	+191950
$M_1{}^B$	+ 46881	−311000	+83000	+ 2955	−424056	+219414	− 69856	−134786
$M_2{}^B$	−584880	−330000	+ 3810	− 136	+ 79017	− 69553	+406517	−397053
$M_3{}^B$	+271761	+ 19000	− 5120	+ 3091	−503073	+288967	−476373	+262267
11*	+ 11094	+ 10800	− 2910	+25892	+ 6000	+ 79000	+ 32700	+ 52300
11	−108406	+ 10800	− 2910	−33858	+ 6000	+ 79000	+ 32700	+ 52300
12	−136030	+ 9900	− 2680	−31400	+ 43480	+ 56800	+ 70180	+ 30100
13	−166580	+ 9000	− 2440	−28850	+ 78580	+ 32500	+105280	+ 5800
14	−195350	+ 8050	− 2170	−26250	+109230	+ 9000	+135930	− 17700
15	−225210	+ 7180	− 1930	−23650	+135320	− 15000	+162020	− 41700
16	−252930	+ 6240	− 1680	−21100	+159000	− 38105	+185600	− 64705
17	−267490	+ 5350	− 1440	−18600	+175970	− 57020	+202490	− 83520
18	−268160	+ 4470	− 1205	−16150	+187580	− 77120	+213680	−103220
19	−256630	+ 3580	− 970	−13650	+196000	− 93730	+221500	−119230
20	−223130	+ 2460	− 665	−10450	+198620	−112100	+223020	−136500
21	−163770	+ 980	− 265	− 6350	+189050	−128200	+211650	−150800
22	− 90437	− 372	+ 100	− 2750	+171840	−137400	+192090	−157650
23	− 16130	− 1610	+ 434	+ 850	+147140	−138400	+164590	−155850
24	+ 56960	− 2730	+ 739	+ 3850	+112940	−130400	+127140	−144600
25	+118390	− 3800	+ 1025	+ 6850	+ 71220	−116500	+ 81720	−127000
26	+160370	− 4630	+ 1250	+ 9100	+ 22920	− 89730	+ 29470	− 96280
27	+172650	− 5400	+ 1450	+11240	− 27280	− 70830	− 25040	− 73070

11* = moment at point 11 below bracket 5.
11 = moment at point 11 above bracket 5.

Table XVa

Table showing final maximum and minimum moments due to any combination of loading on the frame.

Point	Without side sway correction max. negative	Without side sway correction max. positive	With side sway correction max. negative	With side sway correction max. positive
M_1^A	− 38702	+ 75253	− 184302	+220703
M_1^B	−688175	+352250	− 398905	+132836
M_2^B	−988379	neg.	−1315879	neg.
M_3^B	−236432	+582819	− 209732	+560637
11*	pos.	+126786	pos.	+100086
11	−145174	neg.	− 145174	neg.
12	−170110	neg.	− 170110	neg.
13	−197870	neg.	− 197870	neg.
14	−223770	neg.	− 241470	neg.
15	−265770	neg.	− 292490	neg.
16	−313815	neg.	− 340415	neg.
17	−344558	neg.	− 371050	neg.
18	−362635	neg.	− 388735	neg.
19	−364980	neg.	− 390480	neg.
20	−346345	neg.	− 370745	+ 2350
21	−298585	+ 26260	− 321185	+ 48860
22	−230959	+ 81503	− 251209	+101753
23	−156140	+132294	− 173590	+149744
24	− 76170	+174489	− 90370	+188689
25	− 1910	+197485	− 12210	+207985
26	pos.	+193640	pos.	+200190
27	pos.	+185340	pos.	+185340

In these tables, the values of the moments for the points 1 to 10 have not been indicated. These values can easily be determined, however, as the moment line is a straight line between these points for any type of loading.

In order to determine the reinforcing necessary for the frame, and also to find the stresses to which each of the members of the frame is subjected, it is necessary that the magnitude of the thrust at any point be known. The shortest way to obtain these values when all moments are already known, is the graphical method of plotting the funicular polygon for all loads applied on the frame. This

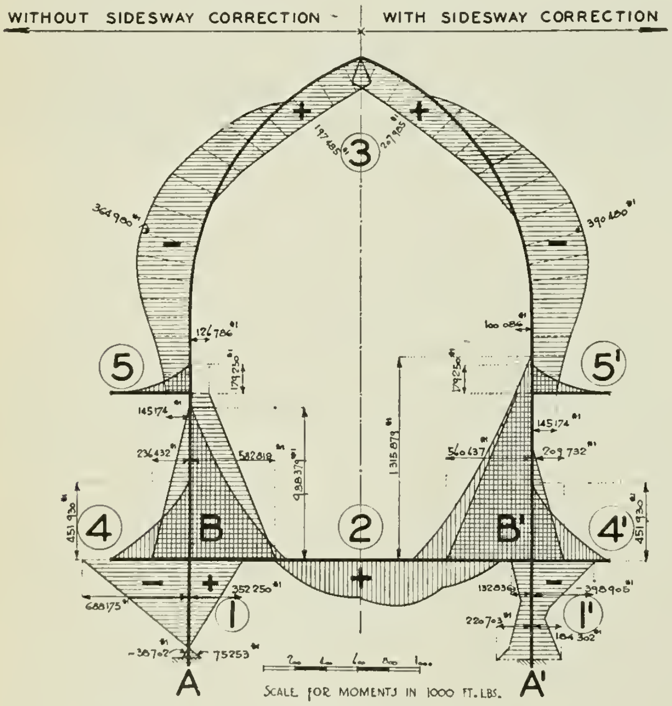

Fig. 23.

method gives at the same time the value of the shear for each section and also a verification of the analysis, as all points of zero moments have to coincide with the points of intersection of the frame axis with the line of the polygon. Figure 24 shows an actual illustration of this graphical method to obtain the direct stresses and shears for the church frame with live loads on beam 2, brackets 4 and 5 and wind on arch 3, in addition to the dead loads of the entire frame.

The following gives an example of determining the influence of an uneven settlement of the footing to illustrate the application of the fixed point method in regard to arbitrarily assumed deformations of any member of the frame.

Influence of an uneven settlement of the footings of the frame.

It is assumed that one of the two footings settles one inch. In order to obtain the bending moments in the entire frame due to such a settlement, it is necessary again to assume that joint B is held temporarily in place to prevent side sway. The moments due to the displacement are then computed, and with the help of these moments the magnitude of the temporary holding force is determined. To obtain the final moments, a load equal to the size and direction to this holding force is then applied at the same point B, but in the opposite direction. The moments due to this load can readily be obtained as they are in direct proportion to the moments which are already calculated to correct the side sway for the wind load moments. (See Fig. 21.)

If the footing A' sinks below the level of footing A by one inch, both beam and arch have to follow this settlement, and are subjected to certain bending moments. These moments are easily obtained with the fixed point method, as all values appearing in the formulae for these moments are already known.

(*a*) *Moments Stage 1.*

Moment at support of beam due to a vertical settlement of one support by one inch.

$$M_2^B = M_2^{B'} = \frac{E \times \Delta \times a_2}{l_2 \times \beta_2 \, [\, l_2 - a_2 - b_2 \,]}$$

$$= \frac{432{,}000{,}000 \times 1/12 \times 19.90}{52 \times 2.14 \, [52 - 19.90 - 19.90]}$$

$$= 527{,}000 \text{ foot-pounds.}$$

Moments at the supports of the arch due to a vertical settlement of one support by one inch.

$$M_3^B = M_3^{B'}$$

$$= \frac{B \left[\frac{l_3}{2} - b_3 \right] \times \Delta \times E \times a_3}{l_3 \times \beta_3 \, [\, l_3 - a_3 - b_3 \,]}$$

$$= \frac{0.01708 \times (52/2 + 56.10) \times 1/12 \times 432{,}000{,}000 \times 56.10}{52 \times [-\,4.535] \times [52.0 + 56.10 + 56.10]}$$

$$= 73{,}100$$

These moments are again distributed around the frame in the manner as shown previously. This distribution is indicated in detail in the following table:

Distribution of end moments of beam:

	M_1^B	M_2^B	M_3^B	$M_1^{B'}$	$M_2^{B'}$	$M_3^{B'}$
527000 × 1.00		−527000				
527000 × 0.962	−507000					
527000 × 0.038			+20000			
20000 × 56.10						+10370
108.10						
10370 × 0.884				+ 9166		
10370 × 0.116					− 1204	
1204 × 19.90		+ 747				
32.10						
747 × 0.962	+ 719					
747 × 0.038			− 28			
Total for end moment at B	−506281	−526253	+19972	+ 9166	− 1204	+10370
Total for end moment at B'	− 9166	+ 1204	−10370	+506281	+526253	−19972
Total for beam 2	−515447	−525049	+ 9603	+515447	+525049	− 9602

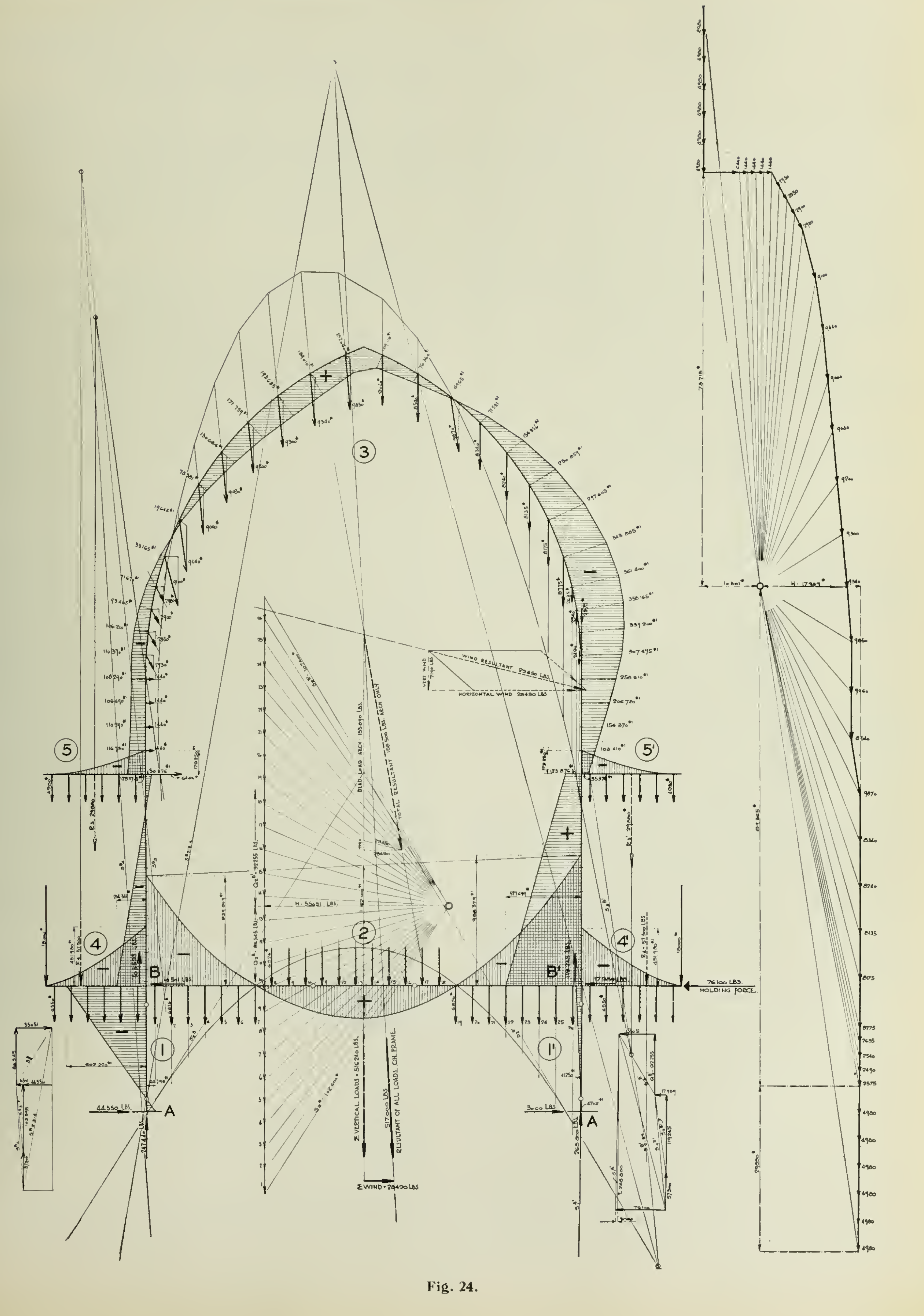

Fig. 24.

Distribution of end moments of arch:

	M_1^B	M_2^B	M_3^B	$M_1^{B'}$	$M_2^{B'}$	$M_3^{B'}$
73100 × 0.884	− 64620		−73100			
73100 × 0.116		+ 8480				
8480 × 19.90					− 5260	
32.10						
5260 × 0.962				− 5060		
5260 × 0.038						+ 200
200 × 56.10			+ 104			
108.10						
104 × 0.884	+ 92					
104 × 0.116		− 12				
Total for end moment at B	− 64528	+ 8468	−72996	− 5060	− 5260	+ 200
Total for end moment at B'	+ 5060	+ 5260	− 200	+ 64528	− 8468	+72996
Total Arch	− 59468	+ 13728	−73196	+ 59468	− 13728	+73196
Total Arch and Beam	−574915	−511321	−63594	+574915	+511321	+63594

The moment at the foot of both columns is

$$\frac{574{,}915}{13.52} \times 1.48 = 63{,}000 \text{ foot-pounds}$$

Horizontal reaction of either support A

$$= \frac{574{,}915}{13.52} = 42{,}500 \text{ pounds}$$

Vertical reactions at both supports A or A'

$$= \frac{511{,}321 + 63{,}594}{26} = 22{,}100 \text{ pounds}$$

(*b*) *Stage II side sway.*

The temporary holding force to keep the frame from swaying sideways at the points B and B' is equal to the shear acting on both columns 1 and 1′. This force is therefore obtained directly thus:

$$H = \frac{M_1^B + M_1^{B'}}{l_1 - a_1} =$$

$$H = \frac{574{,}915 \times 2}{15.00 - 1.48} = 85{,}000 \text{ pounds}$$

This force has to be applied at joint B' in the direction from left to right. The moments due to this force are obtained by multiplying the moments shown in Fig. 21 by the following coefficient.

$$\alpha = \frac{85{,}000}{5{,}580} = 15.23,$$

as Fig. 21 shows all moments in the frame due to a force = 5,580 pounds applied at joint B'. The moments due to side sway are therefore as follows:

$$M_1^A = M_1^{A'} = 15{,}845 \times 15.23 = 241{,}000 \text{ foot-pounds}$$
$$M_1^B = M_1^{B'} = 25{,}981 \times 15.23 = 396{,}000 \text{ foot-pounds}$$
$$M_2^B = M_2^{B'} = 24{,}022 \times 15.23 = 366{,}200 \text{ foot-pounds}$$
$$M_3^B = M_3^{B'} = 1{,}959 \times 15.23 = 29{,}800 \text{ foot-pounds}$$

Reactions

Horizontal reaction at A or A'

$$= 2{,}790 \times 15.23 = 42{,}500 \text{ pounds}$$

Vertical reaction at A or A'

$$= 999 \times 15.23 = 15{,}200 \text{ pounds}$$

The final moments and reactions are obtained by adding the results of Stage I and Stage II, thus

$$M_1^A = M_1^{A'} = 63{,}000 - 241{,}000 = \pm\ 178{,}000$$
$$M_1^B = M_1^{B'} = +574{,}915 - 396{,}000 = \pm\ 178{,}915$$
$$M_2^B = M_2^{B'} = 511{,}321 - 366{,}200 = \pm\ 145{,}121$$
$$M_3^B = M_3^{B'} = 63{,}594 - 29{,}800 = \pm\ 33{,}794$$

Reactions at B horizontal = 85,000 − 85,000 = 0

at A horizontal = 42,500 − 42,500 = 0

at A vertical = 22,100 − 15,200 = 6,900 pounds.

Conclusions.

The result of this analysis shows how dangerous it is for the designer to subdivide the structure into secondary frames by assuming hinges in order to simplify the calculations. In the case of the frame analyzed in this article, it would have been easy to either assume full restraint or two hinges at the base of the arch in order to obtain a frame which is statically indeterminate in the third or second degree. The lower frame could then have been assumed to be a portal frame with only one redundant. Both assumptions would have given misleading results, as it is practically impossible to execute the hinges in a reinforced concrete structure in such a manner, so that they actually work as assumed. On the other hand, the assumption of full restraint would have given an entirely wrong result as far as the distribution of the bending moments are concerned. The fact cannot be ignored any more that those engineers who want to be able to give entire satisfaction to the architect in charge of the design of the building, both from an economical and aesthetic point of view, have to get rid of the old arbitrary and illogical rules and interest themselves in modern statics.

In this article, it has been the intention, after outlining a general explanation of the theory on which the method is based, to give the reader as complete an illustration of the application of the method as possible. By doing so, probably a great number of computations will prove to be superfluous to the experienced designer. On the other hand, it was considered worth while to spend a little more time on the presentation of the text for the benefit of those designers who are probably not very familiar with semi-graphical short-cuts, and who are more at home with analytical methods. The length of this article and the great number of diagrams used for illustrations of the method may give the impression that the method involves rather a considerable amount of time to obtain the final result. But such is not the case, as only one diagram was actually made for the original design of this particular frame embodying all those shown in this article. This saving of time is easily possible for one who is familiar with the method.

Messrs. H. S. Labelle, J. E. Perron, J. M. Lafleur and L. N. Audet were the architects entrusted with the design of the cathedral. The writer, as designing engineer of Arthur Surveyer and Company, was responsible for the structural design.

The Winter Operation of Aero Engines*

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Paper presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, February 1st, 1935.

SUMMARY.—The author describes the conditions of aircraft operation in Canada during the winter and after outlining the laborious technique pursued for several years emphasizes the need for improvement in lubrication and starting technique.

Elimination of cold weather lubrication difficulties is based on the proposition that oil temperature is in itself immaterial and that its only real importance is the effect on viscosity which is regarded as a state rather than as a property. In consequence a variation of oil grade and a premeditated variation of oil operating temperature under adequate control is advanced as the solution and the results of two years practical trial are offered as proof. A brief specification of a desirable oil system is given, together with a forecast of possible developments in the near future to deal with existing lubricants.

Although the author is an officer of the Royal Canadian Air Force, this paper deals only very incidentally with problems peculiar to military aviation. The control of civil aviation in Canada is vested in the Minister of National Defence and the members of the Aeronautical Engineering Division of the Department of National Defence are in close touch with civil aviation whether operated by the government or by private enterprise.

That a clear idea may be gained of the particular problems confronting the operator in Canada it is necessary first of all to describe briefly the fundamental characteristics of most Canadian flying. It is essentially a pioneering activity. All commercial undertakings of whatever nature are designed to fill a need—and the less competition the better. One of Canada's crying needs was better facilities for communication in the immense areas of undeveloped territory to the north of the main transcontinental railway lines. The airplane just naturally slipped in to fill this need in competition against the canoe and dog team rather than entering into the expensive development required to compete against the well organized and efficient east-west communication systems.

Transcontinental aviation is not by any means being ignored but the great bulk of activity is now and will for some time remain in the bush and wilderness territory, and a vast majority of customers is among those whose enterprises are of the pioneering sort such as mining corporations, prospectors, timber cruisers, surveyors, fur traders and so on. The very nature of the operations implies mobility and flexibility and consequently the establishment of elaborate bases is impossible. The home base may be moderately comfortable, although it may itself be some hundred miles from the nearest railway, but the outer terminus will as likely as not be a sand bar or beach or a flat patch of snow in the lee of some sheltering trees or rock. Under these circumstances every airplane must be self-sufficient and must carry all the equipment necessary for its own service and maintenance. It must also carry emergency rations and clothing and fuel for the preservation of the lives of its occupants in the event of a forced landing. It is obvious that the necessity for inflicting all this weight on the poor flying machine makes serious inroads on its pay load.

When winter flying operations started seriously in Canada shortly after the World War, the technique at the commencement and at the termination of a flight was terribly laborious. The author's chief, Group Captain E. W. Stedman, R.C.A.F., M.E.I.C., vividly describes the efforts to start a four-engined Handley Page bomber in quite moderately cold weather in Nova Scotia. He tells of hordes of assistants "chain-ganging" buckets of boiling water into the radiators until the outlets on the far end of the water manifolds ran hot; of pouring hot oil into the tanks; of warming at least 48 spark-plugs on a shovel over a fire and then putting them in; and of the fourth engine sulking and the other three having to be shut down for fear of overheating on the ground; and then of starting the whole process over again. The heart-rending thing was that with one engine running its available horsepower could not be harnessed to start the other three. Later, at a government air station at High River, Alberta, where Liberty-engined D.H.4's were in use, a volatile anti-freeze was employed and each aircraft was fitted with an elaborate still for the recovery of the anti-freeze and its subsequent return to the radiator. The coming of the air-cooled radial engine certainly reduced the difficulties, but even at that they remained very formidable. Oil had to be drained from motor and tank with the engine still running, a risky and most undesirable process. Then it had to be heated all over again and poured into the tanks before the commencement of the next flight, with some likelihood that by the time the motor actually started the oil had become cold and the first few moments of running were done with little or no lubrication.

To ensure a start it has been and still is the practice to warm the motor by encasing it in a heavy canvas cover or a nose tent supported on the vertical propeller and applying heat under the cover by means of a blow lamp, gasoline stove, or even a wood-burning stove. This process takes from half an hour to an hour and the cover has to be removed before an attempt is made to start. The oil was poured in at the last possible moment. If for any reason the engine refused to start the whole process of draining and reheating the oil, replacing the engine cover and warming the cylinders had to be repeated. The mere manhandling of 50 to 100 pounds of oil with its container, and of the heavy bulky engine cover is a labour not to be despised and by the time an aircraft is ready to take off, the crew has already done a goodly part of a day's work and, if it is required to take full advantage of the short daylight hours, a great proportion of the preparatory work and the after-flight work has to be done in the dark. The weight and bulk of the oil containers, engine warming bag or tent, and stove are formidable and if the operation is in a treeless district, such as the barren lands of the Northwest, the difficulty is increased by the necessity for carrying fuel for warmth as well as fuel for power. Incidentally, leaded fuel is not suitable for burning in stoves so special fuel in separate containers must be carried.

For several years these arduous conditions were accepted as the inevitable accompaniment of winter. This sounds like rather a weak admission, but Canadian aviation has no great resources either in spare cash or in engineering personnel to devote to experiment and research and we were for some time quite fully occupied with winter landing gears and allied problems. Commercial operators were busy trying to survive and, having settled on a workable technique, had little time or money to devote to research which was not immediately productive.

Attack on the Lubrication Problem

The urge to reopen the attack on the engine problem arose only a few years ago and came to this individual in a manner which may be worth relating. One trouble encountered was that the oil temperature could never be worked up to the degree recommended by the engine manufacturers. This was countered by an elaborate system

*Paper presented at the annual meeting of the Society of Automotive Engineers, Detroit, January 15th, 1935, and published in the April 1935 issue of the S.A.E. Journal. Reprinted by permission of the Society of Automotive Engineers.

of lagging pipes and tanks, shielding crankcases and plugging up all sorts of cowling openings. This involved a great deal of work which had to be done every fall and undone again every spring, and, from some over-worked maintenance man, the suggestion arose that the lagging and so on be retained as a permanent feature and that large oil coolers be fitted to look after summer requirements. This was too much like asking a man to wear his winter overcoat all the year round and to carry an ice pack with

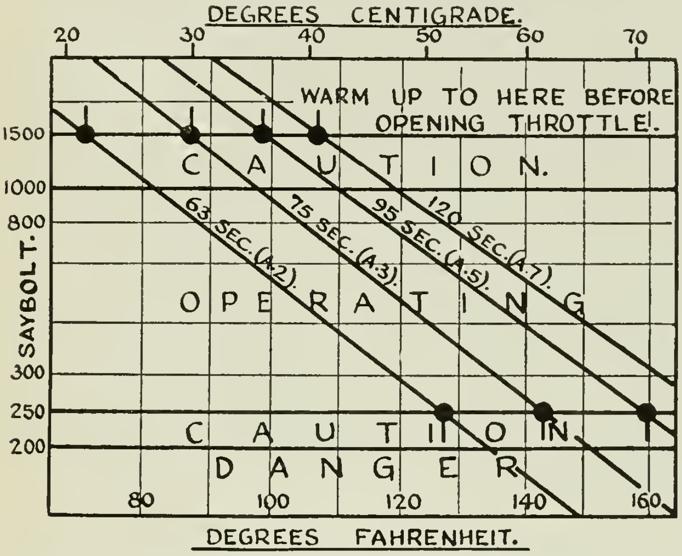

Fig. 1—Viscosity-Temperature Chart. Posted in a Visible Position on every Aircraft in the Royal Canadian Air Force.

him for relief when needed. One's gorge rose in sympathy for the poor overloaded airplane. The objectionable suggestion contained, however, the germ of an old idea and after considerable thought and discussion the Department proceeded to put it to work—in reverse.

Why not work a step or a couple of steps lower on the temperature scale, and use oil coolers in *winter time* to make sure that we remain on the chosen step? After all, a given quantity of fuel burning with a given quantity of oxygen will produce approximately the same amount of heat no matter what the original temperature of the oxygen. Some of this heat is converted into useful energy, a good share is dissipated to the atmosphere through the cylinder walls, directly or through a cooling liquid, some more goes away with the exhaust and a fair proportion is imparted to the oil and thence to the atmosphere. The atmosphere therefore acts as a direct cooling medium for a very considerable proportion of the dissipated heat and, though the exhaust gases will probably be at much the same order of temperature summer and winter, it is quite reasonable to suppose that the general temperature level will be lower in winter than in summer. This supposition is definitely supported by the existence of elaborate shutter systems installed with the sole idea of keeping the temperature up. Any one who has shovelled coal into a furnace during a northern winter can argue this out for himself.

The next supposition is admittedly assailable. Here it is: "If an oil has the proper 'oiliness' and all its other physical and chemical properties are satisfactory, then the physical characteristic which finally determines its suitability as a lubricant under a certain set of conditions is viscosity. Furthermore, viscosity should be regarded as a *state* rather than as a *property* because it varies with temperature."

If this proposition is accepted then a 63 sec. oil at 120 degrees F. is in the same *state* and therefore has the same lubricating qualities as a 120 sec. oil at about 165 degrees F. (See Fig. 1.) If the viscosity indices of the oils are of the same order, then the same deduction could be made if we add a couple of hundred degrees of temperature to each side. The weak point of the chain comes right here.

Is the temperature rise of a 63 sec. oil entering an engine at 120 degrees F. and working in winter of the same order as the temperature rise of a 120 sec. oil entering the engine at 165 degrees F. and working in summer?

Basing our opinion on the established fact of a lowered general temperature level we in Canada decided the point was well worth putting to the test.

Fortunately for our requirements a Wright R975E engine had just completed full type trials for a Type certificate of airworthiness on the test dynamometer of the National Research Council of Canada. The engine had been carefully calibrated for power and had then been torn down, very thoroughly inspected and "miked," and then reassembled for use. Its exact condition, therefore, was well established. This engine was installed in a Bellanca Pacemaker fitted with a controllable oil cooler and with the usual run of measuring instruments for a test of this nature. The aircraft was operated for 200 hours during the winter of 1932-33, observations being made of consumption of fuel and oil, cylinder head temperature, oil pressure, inlet temperature, and all relevant conditions which might have significance; 75 and 63 sec. oils were used and no mercy was given, the aircraft doing a considerable number of full throttle climbs. At the end of the 200-hour period, and incidentally of the winter, the engine was removed from the Bellanca and put on the dynamometer where the power was calibrated again, after which a complete stripping, inspection and "miking" was done. The results, an abstract of which is contained in Appendix I, were sufficiently encouraging to warrant further trials the next winter. Consequently, arrangements were made to fit several aircraft, powered by Pratt & Whitney, Wright and Armstrong Siddeley engines, with the necessary oil coolers, and service trials were done by pilots untrained to test work performing ordinary service functions. No unusual trouble was experienced and we felt satisfied that a lot of the grief of winter flying was being eliminated and that the engines were certainly getting their oil during the first few revolutions—which was a matter of considerable doubt in the old days.

Last winter a Rolls-Royce Kestrel was tackled. This was a different proposition altogether as, being a liquid-cooled engine and the aircraft being fitted with a controllable radiator, the cylinder temperature should be the same winter or summer. To be strictly consistent, the cooling liquid temperature should have been stepped down to a lower figure than that used with the summer oil, but this was not done. The airplane was left exposed out of doors all winter and was started up every day, a number of dead cold starts being effected with no great difficulty at sub-zero temperatures down to as low as −20 degrees F. No real trouble was encountered.

As a result of all this experimentation, the Department felt that the right track was being followed, especially as the automobile industry seemed to be thinking along much the same lines. Consequently, a technical memorandum was published to impart to commercial and private operators the benefit of our experiences. This memorandum, which was written mainly for operators and maintenance men, is contained in Appendix II.

Installation of the lubrication system in an aircraft required to operate in widely varying climatic conditions should include an oil tank or tanks well protected from such external influences as warm air from the cylinders or the cold external atmosphere, and also should include a generous controllable oil cooler in the scavenge line. It is quite a good idea to have the oil feed and return pipes enter the oil tank within the confines of a central enclosure dividing off a gallon or so of oil in the middle of the tank. This enclosure must have feed holes communicating with the main body of oil in the tank, and, if desired, a manually operated bypass in the scavenge line can be arranged to return to the outer section of the tank. The bypass cock must in no position close off both return passages. When the motor is started up, the central body of oil is warmed much more rapidly than would be the whole body in a simple tank and consequently the proper lubrication is effected at an earlier moment. This definitely saves on running up time and on wear and tear at the start.

The oil cooler should bear the whole responsibility for the oil temperature and should therefore be of sufficient capacity to permit overcooling on the hottest summer day. Conversely, if it is completely cut out, overheating should occur on the coldest possible winter flight. Only in this way can the pilot have complete control throughout the four seasons without resort to seasonal modifications, such as shutters and lagging. Thermostatic oil temperature control would be quite satisfactory provided that the thermostat can be set to the correct temperature for the particular grade of oil being used. Our experience with aircraft having common types of air-cooled radials up to 425 h.p., and controllable oil coolers is that 63 sec. oil remains fluid at −20 degrees F. and can safely be used up to an atmospheric temperature of 32 degrees F. and that 95 sec. oil is satisfactory for the upper range except for really abnormal hot weather. Three grades of oil ought to cover the whole year north of the 40th parallel.

Admittedly, people who operate north-south air lines from the 40th to the really low parallels will have to think a bit, but that worry can be left to them. As the development has only been carried down to −20 degrees F. for cold oil starts, and aircraft are quite consistently operated at between −60 and −70 degrees F., the necessity for really rapid oil drainage has not been eliminated. Consequently the drain cock and pipe should be of generous proportions, very easily accessible and should discharge vertically downwards when the aircraft is resting normally on the ground so that there is no necessity to keep on moving the can as the head decreases. The oil filler arrangements should likewise be very large and easily reached. One can't get people to filter oil at −40 degrees F. nor do they want to stand pouring oil out of a can above their heads or in a cramped position at that sort of temperature. The same remarks apply to refueling arrangements but to a lesser degree. To be really safe, filters should be oversize and the oil filters should be duplicated, one on the inlet and one on the scavenge pipe. Great care is required in locating the oil temperature thermometer if provision has not already been made by the engine manufacturer for a thermometer pocket. The measuring element of the thermometer must be well surrounded by the moving stream and must not be in a pocket or back eddy, because quite serious errors of temperature measurement may occur. The present instruments for supervision of the oil condition are the thermometer and the oil pressure gauge. It has been suggested that, as viscosity is the real criterion, a viscometer should be included in the system. Investigations now are under way at the National Research Council laboratories to determine whether a viscometer can be made to tell the truth and, if so, whether the information is of value, and whether the instrument can be used to replace the thermometer and pressure gauge.

Engine and Oil Warming

Three general types of shelters for engine warming have been in general use in Canada: (1) the engine cover, (2) the nose tent, and (3) the nose hangar. The first two are completely mobile while the third is semi-mobile in that it can be knocked down and transported by air if it is found necessary to move a sub base.

The engine cover (Fig. 2) is merely a bag tailored to fit as closely as possible round the engine, vented at the top and provided with a sort of trunk or flue at the bottom into which the chimney of some heating device can be inserted. The bag does not cover the airscrew. Its main drawback is that no maintenance work can be done on the engine while the bag is in place.

The nose tent (Fig. 3) is merely a wigwam shaped affair supported on the tip of one blade of the airscrew and laced around the body of the aircraft. It is usually made of two ply of durable, close-woven canvas. The heating element is placed right inside the tent, provision being made for air inlet and venting. The skirt is spread out and held in place by snow piled on it. The nose tent is necessarily heavier than the simple engine cover, but has the advantage that a limited amount of servicing and maintenance may be performed under it and, in emergency, its shelter may be used for human beings.

The nose hangar (Fig. 4) is a collapsible framework of light metal tubing covered with canvas. It is built of sufficient height to permit turning the airscrew and a split curtain is laced tightly round the body of the aircraft behind the engine. This equipment permits the execution of field maintenance work to the fullest degree but is not intended to be carried as part of the routine winter gear of the aircraft. It is mounted on skids or skis to facilitate placement.

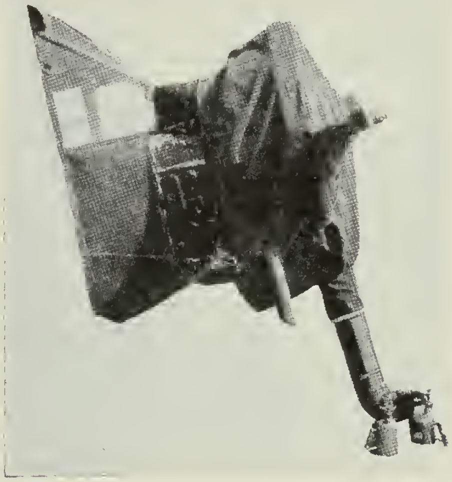

Fig. 2—The Engine Cover. A Bag Tailored to fit as closely as possible around the Engine.

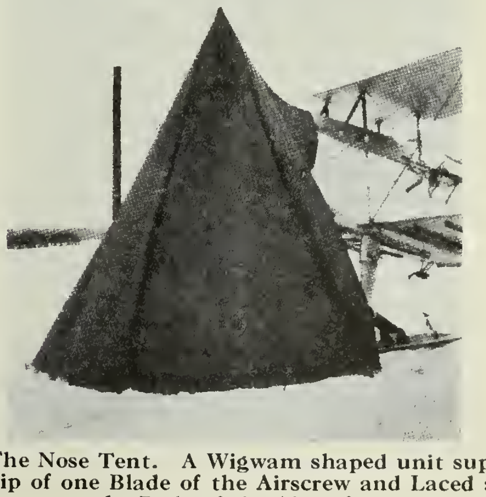

Fig. 3—The Nose Tent. A Wigwam shaped unit supported on the Tip of one Blade of the Airscrew and Laced around the Body of the Aircraft.

Where supplies of wood may be obtained, use is made of a sheet metal stove for warming purposes, but the most usual source of heat is gasoline burnt in a Primus stove or plumber's pot suitably shrouded and flued to take the heat where it will do the most good. As mentioned previously, leaded fuels are not good to burn in these stoves and are definitely forbidden for cooking. Hence a supply of special fuel in separate containers has to be carried. The heat from a large gasoline burner is quite fierce and precautions should be taken to avoid damage to soldered radiators and other vulnerable items, and to avoid danger of fire by providing some sort of control, preferably an automatic one by thermostat. This is most applicable in the case of the simple engine cover and where the metal flue enters the bag, a non-inflammable connection with asbestos is essential.

Fig. 4—The Nose Hangar. A collapsible Framework of Light Metal Tubing covered with Canvas.

None of these equipments make satisfactory provision for warming the oil. On many aircraft the oil tank is situated behind the fire bulkhead and this adds to the difficulty. All sorts of attempts have been made to overcome the trouble. One of these which has some merit is the introduction of a water boiler in the flue of the stove. Steam can then be led through flexible piping to an immersion heater thrust into the oil tank through the filler neck. This is not very efficient as oil does not warm up readily in bulk from a local source of heat. An improvement might be effected by using a built-in steam heating element of efficient design with very thin, closely-spaced fins.

Another suggestion for which a preliminary investigation has already been made in the laboratories of the National Research Council is as follows: The oil tank to be fitted with an internal pierced enclosure surrounding about a gallon of oil as mentioned before but located so that an accessible portion of the outside wall of the tank forms one side of the enclosure, the feed and scavenge pipes to lead through this portion of the wall, and finally a hand pump and three-way cock is to be fitted on a by-pass pipe short circuiting the motor as close as possible to the inlet and outlet connections. (See Fig. 5.) The application of local heat by means of chemical pads, such as the "Thermat" pad made by Bauer & Black, applied to the outer wall of the tank will raise the temperature of a portion of the oil sufficiently to permit it to flow when the hand pump is operated. If in the meanwhile heat from the apparatus which is being used to warm the motor is conducted through the oil radiator, sufficient warm oil for a safe start may be accumulated in a reasonable time without any need to drain the oil, which is one of the main bugbears of the winter operator. The weight of the extra piping, pump and "Thermat" pads may be balanced against the eliminated oil container and the extra fuel required to warm the oil separately. The feasibility of this process has been demonstrated, but practical trials have not yet been made, though it is the Department's intention to make such trials this winter. It will of course occur to every one that the steam immersion heater idea could be applied to this process, thus making one independent of chemical pads.

Ignition and starting

Getting the first kick out of the engine is a ticklish problem and has been the subject of numerous experiments. An organized attack on the problem was commenced under the auspices of the Air Research Committee of the Research Council of Canada by Professor C. H. Robb of the University of Alberta at Edmonton in 1920. Professor Robb continued his experiments for about three winters and forecasted several developments which only now are really being put into practical use, in particular the use of an oil cooler in winter. He used a Liberty engine and the problem was presented to him in this way: "The engine is in an airplane forced to spend a night in the open away from a base. It has been assumed that while the engine was still hot the cooling system has been drained or that an efficient antifreeze mixture is available. It is also assumed that the battery has been removed from the machine and kept at ordinary room temperature and that a supply of commercial ether is available."

Some of Professor Robb's technique would be objected to today as being too brutal. For instance, he recommended supplying the engine by injecting about ½ pint of gasoline and turning the crankshaft over with switches off until the engine worked freely. In extenuation it must be remembered that the starting handle of a Liberty engine took some pretty heavy heaving to get results. The following table gives his recommendations:

Temperature	Gasoline Per Cent	Ether Per Cent
20 degrees F. and warmer.....	100	Nil
0 degrees F. to 20 degrees F. .	75	25
−15 degrees F. to 0 degrees F....	66	34
−30 degrees F. to −15 degrees F.	50	50
Below −30 degrees F...	Nil	100 (warm)

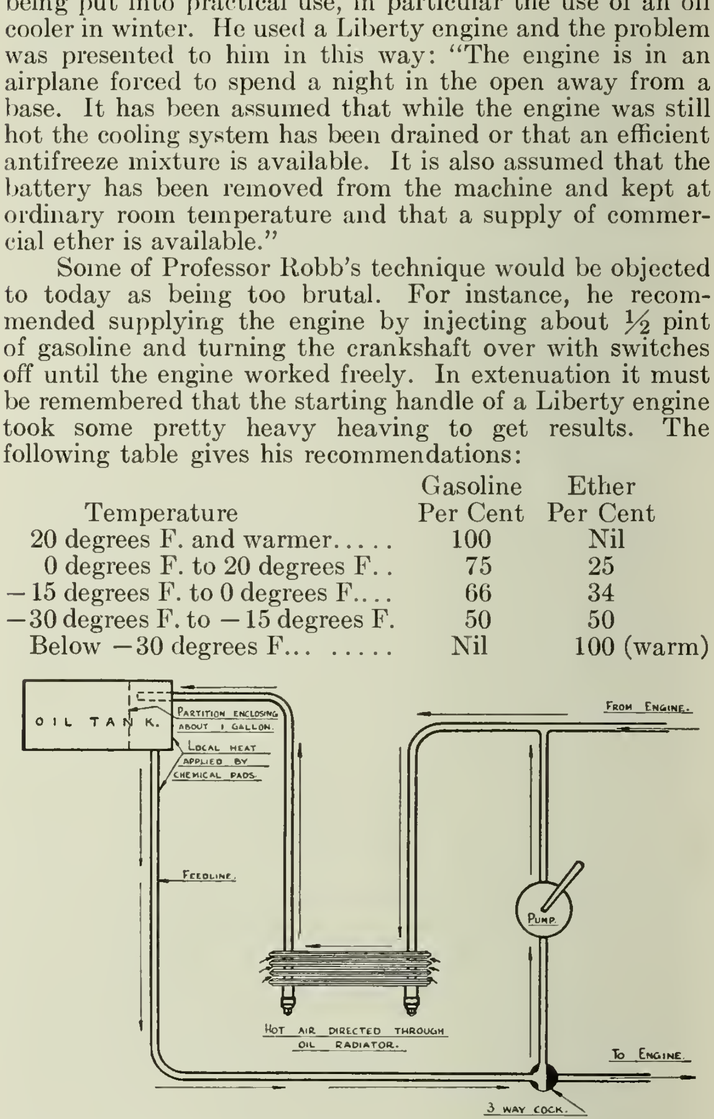

Fig. 5—Suggested Method of Warming Oil in Cold Aircraft Engines on which Canadian National Research Council has made Preliminary Investigations.

About ¼ pint of the appropriate mixture was injected into the intake manifolds and as soon as the engine kicked an additional ¼ pint was shot in. This generally sufficed for the engine to begin to feed on gasoline from the carburetor which had in the meanwhile been flooded. Large capacity priming pumps and nozzles were found to be essential.

It will be noted that under the conditions it was assumed that the battery could be kept at room temperature. This is a concession that we would not care to allow today as the object is to eliminate all possible manual labour. The loss of capacity of storage batteries at low temperatures is a very serious objection to the use of battery ignition in cold climates especially in these times when the poor old battery is asked to do so many things. This is one of the considerations that has led the Department to turn down the booster coil in favour of the hand starting magneto. The aircraft and its crew must be self-supporting and in the final analysis the energy for starting may have to be derived from the calories in the emergency rations supplied for the men. This is not far fetched. Many a pilot in the North has taken the spark plugs to bed with him in the eiderdown bag so as to be sure that they would be warm and dry when required for use the next morning. Incidentally it is quite common technique to warm at least one plug out of each cylinder on a shovel over the engine warming stove. This is not so convenient when a simple engine cover is being used.

To insure lubrication at the start, Professor Robb tried both "Mobil A" and "Mobil Arctic" and decided definitely in favour of the latter. A little "Arctic" was left in the crankcase overnight and the tank was short circuited by means of a bypass with a relief valve leading to the tank so as to control the pressure on the suction side of the oil distributing pump. This idea is similar to that of the segregation of a portion of the oil tank but it has the disadvantage that some one might forget to cut in the main tank.

Experiments were also made at this time with jets of various sizes larger and smaller than the standard high-speed jet. As might be expected, because cold air has more oxygen per unit volume than warm air, the standard jet was inclined to give a lean mixture and the engine was found to take the throttle better with a slightly oversize jet (070 as against 065 on the Liberty).

The danger of vapour lock at high altitude or at high temperature definitely precludes aviation gasoline from being a really easy starter, at least in the present stage of the art. To achieve the ideal of dead cold starts, therefore, it will be necessary to resort to a starting fuel such as ether or some gaseous fuel compressed into a bottle and injected into the intake manifolds. It must be confessed that the lead given by Professor Robb has been somewhat neglected for a long time, but some of the blame can be attributed to the engine manufacturers who were, to say the least, reluctant to tolerate the use of low viscosity oils. So long as the necessity for warming the oil and the motor was accepted, so long was the methodical development of easy starting retarded.

Valve and Accessory Lubrication

There is a fairly strongly supported opinion that much of the difficulty of getting the first kick can be attributed to poor compression caused by sticky valves. This immediately brings up the question of valve lubrication and it is a fact in Canadian experience that liquid-cooled engines start more easily than the air-cooled type. In the effort to get a clean engine which does not foul the windscreen, there is a suspicion that we in Canada, at least, have gone a step too far in packing the valve rocker boxes with over heavy grease. The winter grease is, of course, lighter than that used in summer, but even at that it is probably unnecessarily viscous. The introduction by Pratt & Whitney of pressure lubrication to the valve gear will probably prove to be of definite advantage in cold weather operation, though the drainage of the oil from the lower cylinders through the exposed manifold of apparently rather small dimensions may be attended by some trouble unless low-viscosity low-pour-point oil is used. It is, however, encouraging to relate that in a certain engine with which we had to deal a low pressure lubricating pipe leading forward outside the crankcase to the reduction gear case was looked upon with considerable suspicion and a special pressure gauge was fitted to supervise it and yet no untoward events happened.

It may be taken as axiomatic from the point of view of the cold weather operator that all lubrication of the motor and its accessories should depend on one single supply of oil under pressure with the possible exception of the starter which begins to turn before the pressure pump gets going. So far as the author knows the problem of cold weather lubrication of packed bearings, such as are installed in electrical machinery, has not been tackled seriously and probably needs some attention. It does not appear to be vital.

The inertia starter is the most commonly used kind in Canada and it is absolutely essential to prepare it for winter use by cleaning it thoroughly and repacking with a low viscosity lubricant. This applies whether the starter is electrically energized or wound up by hand.

Icing of Carburetor

One of the worst bugbears of cold weather flying is the danger of icing up in the choke of the carburetor. Many carburetors are furnished with a special heating jacket round the choke housing to forestall this evil. In Canada we probably suffer less from this than most countries in the northern temperate zone, because, with the possible exception of the coastal regions, the relative humidity of the atmosphere is comparatively low for the greater part of the winter. Trouble is definitely experienced in the fall and spring. The accepted method for combating the evil is to reduce the relative humidity of the intake air by warming it. The cheapest way is to use the air that has just finished cooling a nice hot cylinder or two, but if this device entails an air intake inside the cowling it is wise to fit a flame trap as an ordinary precaution against fire. The air intake positively must drain to the outside of the cowling. Heat from exhaust gases is frequently employed to warm the incoming air, but this involves extra complication and expense in the exhaust system and especially careful inspection and maintenance to insure that the engine will not be fed through leakages with some of its own exhaust.

Future Ambitions

Although much of this paper is devoted to describing methods for warming motors and oil tanks, emphasis should be placed on the efforts to eliminate all this unproductive labour. Our proposals for engine warming and oil heating are merely made with a view to finding good expedients to carry through until the ideal is reached. So far, as implied before, the stage has been reached where a 63 sec. special low pour oil can be used dead cold for a start at −20 degrees F. Unfortunately not all motors will start at this temperature and the immediate problem is to get the technique for cold motor starting into line with the progress on lubrication. When that has been achieved it is proposed to aim at a figure of some −40 degrees F. It nearly all depends on the wonderful efforts of the petroleum technologists who are certainly learning to weave their molecules into newer and more pleasing patterns every day. A lot of people will consider that 63 sec. oil is beyond the pale of reason already but there is little cause to doubt that there will soon be available a 53 sec. oil with a remarkably good viscosity index and in the meanwhile we can make sure of the ground where we stand. The ultimate aim to be achieved is dead cold starts at temperatures just above the freezing point of gasoline, namely, around −70 degrees F., which is about the limit of human endurance. Before we ever reach this point, however, there is quite a possibility that the internal combustion motor will be displaced by a steam powerplant, which has many attractive possibilities for winter operation, and that gasoline as a fuel may give way to something else altogether.

APPENDIX I

Some results of tests of low viscosity oils used in a Wright R975E Engine installed in a Bellanca Pacemaker.

Oils Used

Imperial Marvelube............................A3
Imperial Marvelube............................A2 (1928)
Imperial Marvelube............................A2 Special (63 sec.)

Average Oil Consumptions

A3......................................2.4 pt. per hr. (16 hr.)
A2 (1928)...............................2.4 pt. per hr. (60 hr.)
A2 Special..............................3.16 pt. per hr. (115 hr.)

Note:—Average r.p.m. were somewhat higher when using the A2 Special than with the other oils.

Maximum Oil Consumption Recorded

A2 Special...4.1 pt. per hr.

Range of Cylinder Head Temperatures
Cruising 1,700-1,800 r.p.m.

No. 1 cylinder...350-450 deg. F.
No. 4 cylinder...300-400 deg. F.
No. 7 cylinder...300-400 deg. F.

Oil Temperatures Maintained

Grade	Maximum	Average
Marvelube A3	56 deg. Cent.	52 deg. Cent.
Marvelube A2 (1928)	53 deg. Cent.	45 deg. Cent.
Marvelube A2 Special	54 deg. Cent.	45 deg. Cent.

AIRCRAFT V. C.—ENGINE C. W. 155. Oil Marvelube A-2 Special A. 303/32 Date—March 17, 1933

Time		Oil Temperatures Deg. Cent.			Oil Pressure		Cylinder Head Temperature Deg. Fahr.				Cooler and Engine Shutter 1-Full Open					
Hr.	Min.	Into Cooler	Out of Cooler	Into Engine	Engine	Cooler	No. 1	No. 4	No. 7	Mixture Control 1-Full Open	C	E	Altitude Ft.	Air Speed Indicator M.P.H.	Air Temperature Deg. Cent.	R.P.M.
..	00	22	16	14	..	..	...	...	...	..	..	..	Ground	..	....	....
..	01	21	15	12	50	12	...	...	...	1	0	0	Ground	..	....	760
..	02	20	15	12	53	11	...	...	...	1	0	0	Ground	..	....	800
..	03	19	15	12	52	10	...	...	...	1	0	0	Ground	..	....	790
..	04	20	16	13	51	11	...	...	...	1	0	0	Ground	..	....	800
..	05	20	16	14	52	11	250	210	240	1	0	0	Ground	..	....	810
..	10	23	20	17	50	10	270	240	270	1	0	0	Ground	..	....	820
..	15	29	25	23	60	10	430	380	410	1	1	0	1200	79	− 3	1840
..	20	39	34	25	58	8	420	380	410	1	1	0	3900	74	− 9	1820
..	25	46	40	32	59	8	380	330	360	½	1	0	4200	87	−11	1750
..	30	48	40	36	59	8	390	320	360	½	1	1	4350	91	−10	1760
..	35	47	40	36	59	9	400	320	360	½	1	1	4350	90	− 9	1760
..	40	47	39	36	60	9	400	320	360	½	1	1	4500	90	− 9	1770
1	00	46	39	33	60	9	400	330	350	½	1	1	4500	92	− 8	1780
1	30			Landed at St. Hubert.				No Readings taken								
2	00	45	40	33	59	10	400	320	360	½	1	0	6100	86	−12.5	1750
2	30	45	38	32	60	10	380	310	340	½	1	0	6800	85	−13.5	1780
3	00	44	37	30	60	10	380	300	340	½	1	0	6500	93	−14.5	1780
3	30	43	35	30	60	10	370	300	340	½	1	0	6800	89	−16	1780
4	00	44	37	31	60	10	360	330	330	½	1	0	6300	90	−15	1750
4	30	42	37	29	59	10	370	300	340	½	½	0	6700	85	−14	1780

A. S. I. No. 23571—Altimeter No. 2496—All-up Weight 4,300 pounds.

Ground temperature..........1.0 deg. Cent.
Wind.....................N.W. 20 m.p.h.
Altimeter reading—Feet.
Surface.........Sticky snow 6-8 inches deep
Take-off time.......................32 sec.

Oil Data

Temperature in tank after filling....................15 deg. Cent.

	Gross	Net
Weight in	50.0	..
Weight out	31.0	..
Consumption	19.0	..
	3.5 lb./hr.	

Fuel Data

Gallons in after flight.....................70
Consumption..............13.7 gal. per hr.

Time—Engine and Flying

Engine on................ 1250 hr.
Off...................... 1815 hr.
Engine time.............. 5 hr. 25 min.
Take-off................. 1300 hr.
Land..................... 1815 hr.
Flying time.............. 5 hr. 5 min.

Starting Engine
NO DIFFICULTY
Skis—Remarks—E Type.

Performance good considering surface conditions.

Time	Oil Temperatures Deg. Cent.			Oil Pressure Lb. Per Sq. In.		Cylinder Head Temperature Deg. Cent.			Air Speed Indicator		Air Temperature	
Min. Sec.	Into Cooler	Out Cooler	Into Engine	Engine	Cooler	No. 1	No. 4	No. 7	M.P.H.	Altitude Ft.	Deg. Cent.	R.P.M.
Ground	24	24	18	62	11	380	320	360	..	....	−2	1740
1–35	34	30	24	60	9	420	380	400	85	1000	−4	1840
2–55	36	32	27	60	9	420	380	400	83	2000	−7	1860
4–35	40	35	29	59	9	420	380	400	77	3000	−7.5	1820
6–20	42	37	30	58	8	440	390	400	75	4000	−8	1820
8–20	45	39	30	58	8	440	380	400	73	5000	−8	1830
10–15	48	41	31	58	7	430	380	400	74	6000	−8	1840
12–45	50	43	32	57	7	420	370	400	75	7000	−7	1850
15–30	52	44	34	57	7	410	360	390	74	8000	−5.5	1860
17–15	53	45	35	56	7	400	360	380	73	9000	−6.5	1860
21–00	54	44	34	57	7	400	360	380	72	10000	−8	1860

Note: Oil temperature dropped to 48 deg. Cent. in 15 min. cruising 1,750 r.p.m., Air Speed Indicator, 76 m.p.h. at 10,000 ft.
Cooler and engine shutters open.

Head temperatures after 15 min. cruising—	No. 1	No. 4	No. 7
	400	340	360

Full throttle climb to 10,000 ft., ground temp. −2 deg. Cent. Marvelube A-2 Special Oil. Date, March 13, 1933. Engine and cooler shutters open. Mixture control adjusted for best running. Aircraft on skis.

APPENDIX II

Technical Memorandum No. 104

Issued by

Aeronautical Engineering Division
Department of National Defence

LUBRICATION OF AERO ENGINES

1. The wide range of climatic conditions which are encountered in different parts of the Dominion of Canada has necessitated extensive experimental work by the Department of National Defence with the object of developing a general technique to meet the requirement of aero engine operation under extreme temperature conditions, with particular reference to extreme cold.

2. For the purposes of this memorandum it will be assumed that the chemical properties of lubricants are not under discussion and that the physical properties including the elusive property best described as "oiliness" are acceptable. The physical characteristic known as viscosity then stands out as having a ruling influence on lubrication.

3. In explanation of viscosity the following quotation from Glazebrook's Dictionary of Applied Physics will serve admirably:

> "When relative motion exists between neighbouring portions of the same fluid, a measurable resistance to the relative motion can be observed and affords a proof that actual fluids are capable of sustaining shearing stresses; the fluid is said to exhibit the property of viscosity or internal friction."

The relation between the shearing stress in a fluid and the rate of distortion (or flow) of the fluid is known as the coefficient of viscosity and it is useful to regard this coefficient as a state rather than as a property or characteristic because it varies with temperature. It is then easy to understand that a lubricant must not only possess the right properties, but must be in the right state in order to perform its functions satisfactorily.

4. In any given aero engine the oil feed pump and relief valve are designed to work within fairly well defined limits, that is to say the applied shearing stress which creates the flow of lubricant is approximately fixed and consequently for a given range of flow the coefficient of viscosity must also remain within fixed limits. If the coefficient of viscosity is too high the flow will be too small and though the oil film in the plain bearings may be strong enough to take the bearing pressure there will not be enough oil spilt to lubricate the cylinders and pistons. Conversely if the coefficient of viscosity is too low there will be too much spillage and the plain bearings will be starved. Departure from the range of viscosity accepted in general practice would necessitate alteration of the oil feed pump and of the clearances in the engine.

5. As correct lubrication depends on rate of flow at a given pressure and as the rate of flow depends upon the coefficient of viscosity which in turn depends on temperature it will be clear that the oil pressure gauge and temperature gauge provide approximate but quite adequate means of supervision of the state of the lubricant in the engine.

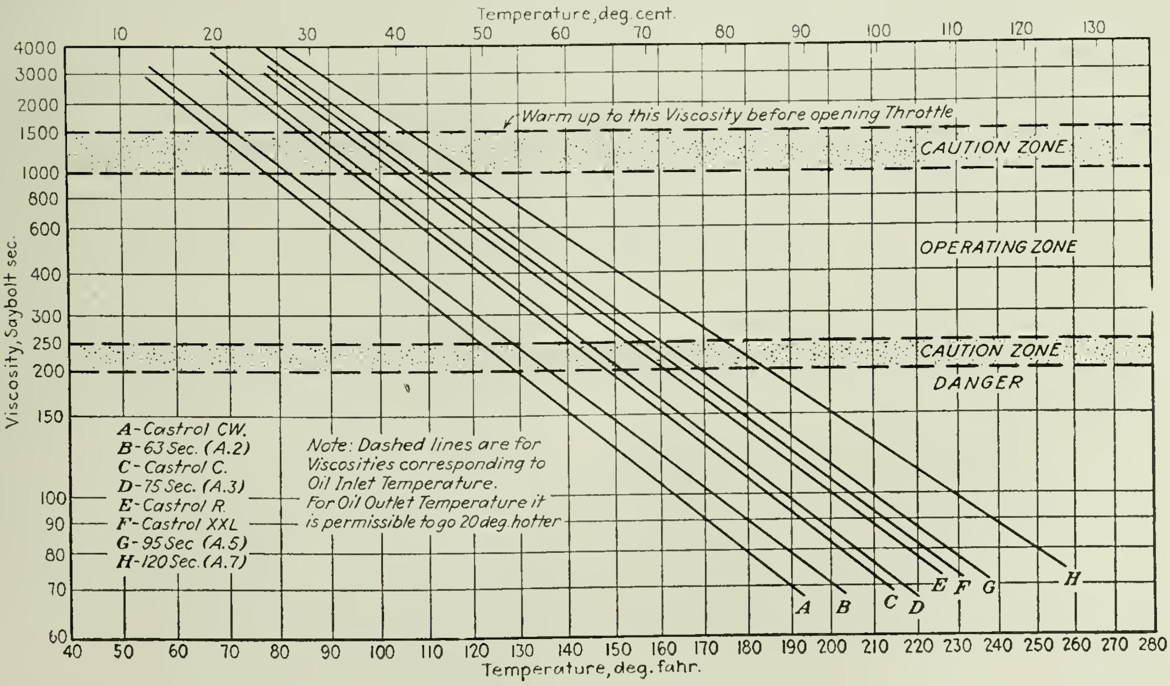

Fig. 6.—Viscosity and temperature for various oils.

6. Nearly all engine manufacturers issue recommendations concerning the grade of oil and the corresponding temperature and pressure found by experience to be suitable for their engines. It must be borne in mind that a statement of recommended oil temperature means nothing at all if it is not accompanied by a complementary statement of the grade of oil, but if the whole information is given the correct state of the lubricant in the working engine can be inferred, and the inference may be used with intelligence and discretion in the deliberate variation of temperature with grade to meet different atmospheric conditions.

7. The accompanying chart A.S.S. 138 (Fig. 6) shows the relationship between Saybolt viscosity and temperature for a number of well known oils. A Centigrade scale is given at the top and a Fahrenheit scale at the bottom. Study of the chart will show that the permissible range of viscosity is wide, and that the oil for curve "*A*" will have the same state of viscosity at 120 degrees F. as the oil for curve "*H*" at 172 degrees F. Actually it will be found that most aero engines work very near the lower boundary of the operating zone, and it is quite possible, and even probable, that this boundary will be lowered, but the Department has no experience so far to justify such action immediately. The modern automobile works much lower down, but seldom works continuously at high throttle openings. The chart has been prepared for oil inlet temperatures, and the preferred position for the oil temperature gauge is in the inlet line, as this gives a more direct indication of the state of the oil entering the lubrication system. A rough assumption has been made that the outgoing oil is 20 degrees F. hotter than the ingoing oil, but this may not be even nearly correct in some installations, and it is strongly recommended that owners should check this for themselves if their aircraft happen to be fitted with a temperature gauge on the outgoing oil line only.

8. During periods of abnormally high atmospheric temperature the cooling of the whole oil system will be reduced and the temperature of the oil stream increased. The drop in viscosity corresponding to the increased temperature increases the flow through the engine with a further increase in the temperature of the oil stream. Provided that a stable condition of oil temperature and viscosity within the limits of the chart is obtained without appreciable loss of oil pressure the engine may be operated safely though an increase of oil consumption is to be expected. Recourse may be had to an oil of higher viscosity if 120 sec. oil Ref. No. 34A/15 is not already in use. It is not considered desirable to use oil of viscosity greater than 120-125 secs. as any advantage gained during full throttle operation or when climbing will be more than offset by a sudden change from the abnormal atmospheric conditions, and during warming up. Failure to obtain stable conditions of temperature, within the limiting temperature range, in the oil stream even in abnormal high atmospheric temperatures may be taken as an indication of defect in the installation and should be reported as such.

9. Extensive warming up periods, during cold weather may be accompanied by excessive wear of cylinder walls and pistons with a certain amount of "scuffing" of the surfaces which will result in further wear when the engine is placed on load and reduction in the life of the engine to a greater extent than occurs during summer flying operations. Several methods, which may be used separately or together, are available for preventing this trouble; viz.:

(*a*) Change of oil to a lighter grade, when the normal cooling effect of the system is such that the desired viscosity of the oil going into the engine can be maintained.

(*b*) Similar to (*a*) but to a lesser degree by addition of oil of a lower viscosity, to that already in the system. This method should be confined to oils of the same brand as it is not desirable that castor or castor compounded oils be added to mineral oils.

(*c*) On training aircraft operated in the vicinity of an aerodrome the minimum quantity of oil permitted by the engine manufacturer plus the amount of the estimated consumption for a convenient period of flight may be used to provide a more rapid flow with correspondingly shorter time required for warming up.

(*d*) Preheating the oil.

10. Outside the engine a good lubrication system should include an oil tank, or tanks well protected from the warm air from the engine and from the cold atmosphere, and a controllable oil cooler in the scavenge line. The cooler should be of such a capacity as to keep the oil temperature under the pilot's control over a considerable range of atmospheric temperature. In this way two or three grades of oil may be made to do for the entire climatic variation in Canada throughout the year. On aircraft not fitted with oil coolers it will probably be necessary to use a greater number of grades of oil. On wet sump engines the variation of grade from that recommended by the manufacturer must be done with great caution, for though it is most desirable in cold weather to use a low viscosity oil for starting, it must be remembered that when running the wet sump engine is not affected by outside conditions to the same extent as a dry sump engine, and the upper temperature limit of the oil is not controllable.

11. The Department's experience with aircraft having common types of radial air cooled engines up to 425 h.p. and controllable oil coolers is that 63 sec. oil (curve "*B*" on the chart) remains fluid at 20 degrees F. below zero, and can be safely used up to an atmospheric temperature of 32 degrees F., and that the 95 sec. oil (curve "*G*") is satisfactory for the upper range of atmospheric temperatures, except for really abnormal hot weather. In radial engines without oil coolers it is thought to be advisable to change to 75 sec. oil (curve "*D*") for the atmospheric range 0 degree F. to 32 degrees F. For temperatures below −20 degrees F. 63 sec. oil should be warmed before starting up, but as it is probably necessary to warm the engine anyway to get a start, the one source of heat may be enough to heat the oil in the tanks as well as to heat the engine.

12. The primary reason for oil changing is to remove the solid matter which accumulates in the oil system. A portion of this material will settle out while the remainder is held in suspension. It is doubtful if the particles which are fine enough to be held in suspension are sufficiently large to cause damage to the bearing surfaces, but the sediment is agitated by circulation of the oil and may contain particles of considerable size though sufficiently small to pass the oil strainer screen. The most serious result of this sediment is its precipitation in the crank pins by centrifugal action and the possible sealing of the oil channels to the connecting rod big end bearings which also cuts off the supply to the cylinders and pistons. Oil changing, when necessary, should take place immediately after the engine has been run, to minimize the quantity of sediment remaining in the system. Twenty (+ −5) hours flying is a safe period between oil changes for present engine installations, based on normal operation. It is reasonable to use a shorter period when conditions of operation have been abnormal, that is, long periods of full power, overheating, etc., and on training aircraft operated from sandy or dusty aerodromes.

E. W. Stedman, Group Captain,
Chief Aeronautical Engineer, R.C.A.F.

Addendum

1. With reference to paragraphs 6, 9, 10, and 11, of this Memorandum, it is desired to emphasize that they are in no way intended to prompt any departure which would not meet with the full approval of the engine manufacturers. Operators are, on the contrary, advised to maintain the closest touch with the manufacturers of their engines concerning the problems under discussion, and they should understand clearly that the full benefit of the use of lighter grades of oil cannot be achieved without the use of an adequate controllable oil cooler.

APPENDIX III

Weights of an Existing Engine Warming Equipment

Engine cover	28 pounds
Chimney and thermometer	19
Chimney base and primus stove	8
Lighting stand	5
Flexible piping	3
Auxiliary primus burner	4
Gasoline container (pressure vessel)	18* (empty)
Methylated spirit	1
Oil container	17*
	103 pounds

*Capable of reduction by redesign.

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VOLUME XVIII SEPTEMBER 1935 No. 9

Winter Landing Gear for Aeroplanes

Winter flying in Canada has now increased to such an extent that there is probably no other country in the world to-day where adequate equipment for flying in the winter season is a greater necessity. Accidents, it is true, have been comparatively few, but many practical difficulties are encountered and aircraft operators are interested in any means for improving the winter performance of their machines.

In this country special precautions have of course to be taken in engine operation under low temperature conditions, but serious trouble may also arise in landing or taking off from snow or ice, not only in the depth of winter, but also in the spring, when the ground is bare and perhaps soft in some places, and in others still covered with snow. Some form of landing gear incorporating skis in place of wheels is therefore necessary, and it is difficult to devise landing gear of this type which will be equally serviceable in all snow conditions.

As a result of prolonged experiments, these difficulties have been largely overcome. With any form of ski, however, it is found that the air resistance due to such landing gear is high, and a very considerable decrease in performance results when wheels are replaced by skis.

Elsewhere in this issue there appears a paper on the winter operation of aero engines. It would therefore seem appropriate to comment on a report* recently issued by the National Research Laboratories on the Aerodynamic Characteristics of Aircraft Skis.

This report covers systematic tests carried out in collaboration with the Department of National Defence, the Ontario Provincial Air Service and companies operating aircraft in Canada, which have measured these aerodynamic losses and have also indicated that the pitching moments of the skis now in use give rise to serious problems in trimming gear design.

It is apparent that the present practice of incorporating a heavy trimming gear in the form of shock cords and check cables attached to the front and rear of skis entails extra air resistance. In fact, this alone is responsible for some thirty-three per cent of the total minimum drag of the ski and its trimming gear.

The difficulties to be overcome in developing an improved design of ski were many, as it was necessary not only to reduce air resistance but also to reduce the magnitude of the unstable pitching moments in order that some form of internal trimming gear might be used and thus avoid the use of exterior cables. So well have the investigators succeeded, however, that a new design of stream-lined ski has been developed which allows an eighty-two per cent reduction in drag and has greatly improved pitching moment characteristics.

The result of these investigations has been that definite recommendations have been made with regard to the design of winter landing gear, in order that the full advantage offered by the new stream-lined ski may be realized. The main points of these recommendations are that the ski pedestal should be of the rigid type and should be used in conjunction with a specially designed ski undercarriage. If this special carriage is not possible the shock absorbing unit of the under carriage in use should be capable of a double range adjustment, and finally the ski trimming gear should be enclosed in the ski itself.

The results of the actual service tests to be carried out on the Department of National Defence Hawker *Audax* plane using the improved design of ski will be awaited with interest.

*The Aerodynamic Characteristics of Aircraft Skis and the Development of an Improved Design, by J. J. Green and G. J. Klein.

Subsurface Exploration at Shallow Depths

In the extensive programme of highway construction which is being carried out in the United States the need has arisen for a rapid method of determining subsurface conditions without the expense and delay caused by boring or sinking test pits. The location of gravel deposits, the classification of material likely to be encountered in excavation along the proposed route, and the depth at which consolidated rock will probably be found, are examples of the kinds of problem which occur, and marked progress has recently been made in the application of geophysical methods to their solution. The highway engineer has to deal with the materials existing at shallow depths, and it has been found that the technique employed in deep geophysical work can be considerably simplified.

Experimental work on geophysical methods of determining earth character at shallow depths has been under review by the United States Bureau of Roads during the past two years and progress has now been reported.*

Two methods have been under test; the electrical resistivity method and the seismic method and the practicability of the latter for normal foundation operations has been demonstrated.

Though well established for deep geological determinations, the seismic method has been handicapped for highway work and the planning of foundations for bridges and other structures by the heavy equipment commonly used. It has now been found possible, however, to simplify this equipment and make it easily mobile and adaptable to rapid work.

*Subsurface Exploration by Earth Resistivity and Seismic Methods, Division of Tests, U.S. Bureau of Public Roads.

In the seismic method of exploration the wide difference in the acoustic properties of plastic and granular matter and rigid or consolidated matter is utilized. Sand, clay or gravel transmit wave disturbances, sound waves, at velocities of 1,000 to 6,000 feet per second, while rigid materials such as rock, transmit disturbances at 16,000 to 20,000 feet per second. Here, therefore, is a means of measuring directly that property, namely rigidity, with which the engineer is concerned, while the resistivity method measures this property indirectly, or through its relation to electrical resistivity.

The seismic method would appear more definite in the identification of solid rock than is the resistivity method, but cannot readily be used to distinguish between clay and coarse sand or gravel as can often be done with the latter method.

While experimental and limited to one locality, the results of work with the seismograph have proved so promising that there would appear to be little doubt as to its ultimate value in the study of subsurface formations.

The Duggan Medal and Prize

George Herrick Duggan, D.Sc., LL.D., M.E.I.C., the donor of the recently established Duggan medal and prize, graduated from the University of Toronto in 1883, and commenced his engineering career with the Canadian Pacific Railway Company. In 1886 he joined the staff of the Dominion Bridge Company, and was appointed chief engineer in 1891. In 1901 Mr. Duggan became assistant to the president of the Dominion Iron and Steel Company and the Dominion Coal Company, and was promoted to second vice-president and general manager of the Dominion Coal Company in 1904. In 1910 he returned to the Dominion Bridge Company as chief engineer, and later became general manager and vice-president, being appointed president in 1918, which office he still holds.

Mr. Duggan joined the Canadian Society of Civil Engineers as an Associate Member in March 1888 and

G. H. Duggan, D.Sc., LL.D., M.E.I.C.

was elected a Member in 1890. He served on Council for nine years, was vice-president for five years, and President in 1916, and was the recipient of the Sir John Kennedy Medal in 1931.

He is vice-president of the Royal Bank of Canada, and director of numerous Canadian organizations, including the Steel Company of Canada, the Dominion Steel and Coal Corporation, the Montreal Trust Company and the Wayagamack Pulp and Paper Company.

Mr. Duggan is a Doctor of Science, and received the honorary degree of LL.D. from both McGill and Queen's Universities.

Rules Governing the Award

A prize of a medal and cash to a combined value of approximately $100.00 will be given each year, from the proceeds of a donation by Past-President G. H. Duggan, D.Sc., LL.D., M.E.I.C., for the purpose of encouraging the development of the branches of engineering in which he practised.

The prize shall be awarded for the best paper presented to The Institute in accordance with the following rules:—

1. Competition shall be open to all members of The Institute.
2. The papers shall be presented to The Institute either at the regular meeting of a branch or at a professional meeting of The Institute, or directly to Headquarters. They shall not have been presented previously to any other body or meeting.
3. Papers to be eligible for this competition shall deal with such subjects as arise in that sphere of constructional engineering which concerns the use of metals in moulded or fabricated shape for structural or mechanical purposes. Without limiting the generality of the foregoing, it is suggested that papers describing works should deal with the economic and theoretical elements of design, fabricating, machining, transporting, erecting, problems solved, methods of overcoming difficulties and other interesting features.

   There will also be admitted to the competition papers describing new methods or the recording of important tests that add to engineering knowledge.
4. Papers shall be the bona-fide production of the author and proper credit shall be given for any assistance received from other parties, partners or reports. The relation of the author to the work shall be clearly stated. Papers shall be compiled and arranged with proper regard to literary value and shall constitute worthy contributions to the records of the engineering profession.

   In judging the competition consideration will be given to the personal knowledge and appreciation of the problems and processes involved and the joint application of theoretical and practical considerations to the execution of the subject which are displayed on the part of the author.
5. The papers shall be judged by a committee of three corporate members, eminent in the corresponding branch of the profession, appointed for the purpose by Council as required.
6. The award shall be made only when a paper of sufficient merit is presented. The prize year shall be from July 1st to June 30th and papers must be presented to Headquarters of The Institute by the 30th day of June.
7. The prize shall be awarded at the Annual Meeting.

Annual Meeting 1936

At the meeting of Council held on June 18th, 1935, the invitation of the Hamilton Branch to hold the Fiftieth Annual General and General Professional Meeting of The Institute at Hamilton in February, 1936, was accepted with appreciation.

OBITUARIES

Reginald Walter Brock, M.E.I.C.

Widespread regret will be felt at the death of Reginald Walter Brock, M.E.I.C., which occurred in an aeroplane crash at Alta Lake, B.C., on July 30th, 1935, when the plane nose-dived shortly after a take-off.

Dean Brock was born at Perth, Ont., on January 10th, 1874, and graduated from Queen's University, Kingston, in 1895, with the degree of M.A. He later did post graduate work at Heidelberg University. From 1902 until 1907 he was a professor at Queen's University, and in 1907 he was appointed director of the Geological Survey of Canada. In collaboration with F. L. Congdon, Dean Brock prepared the draft which forms the basis of Canadian mining laws. In 1914 he served as deputy minister of Mines at Ottawa, and resigned from that office to become Dean of Applied Science at the University of British Columbia, at Vancouver, which appointment he held until the time of his death. He had been on leave of absence from the University since December, 1934, when he was appointed chairman of the Vancouver Board of Harbour Commissioners.

Dean Brock organized the 196th Battalion, known as the Western Universities, and served under General Allenby in Palestine and Syria with distinction, bearing the rank of Major. At the time of his death he was Lieutenant-Colonel, and officer in command of the 72nd Highlanders, Vancouver.

For more than ten years, Dean Brock and his associates at the University were engaged in making a geological survey of the Island of Hong Kong for the British government, and in 1933 he had leave of absence from the University to complete the task.

He possessed the degrees and honours of LL.D., (Queen's University, 1921), LL.D., (Hong Kong), F.G.S., and F.R.S.C. He was internationally known as one of the greatest geologists in the history of Canada.

Dean Brock held at various times the following offices: vice-president of the American Society for the Advancement of Science, general secretary of the International Geological Congress, and royal commissioner for the Frank, Alta., landslide. In May of this year he was elected president of the Royal Society of Canada.

He became a Member of The Institute on June 7th, 1924.

Frank Henry Pitcher, M.E.I.C.

Deep regret is expressed in placing on record the death at Montreal on August 21st, 1935, of Frank Henry Pitcher, M.E.I.C.

Mr. Pitcher was born at Montreal on December 21st, 1872, and graduated from McGill University in 1897 with the degree of M.Sc.

In the years 1894-1899 Mr. Pitcher was a demonstrator and lecturer in physics at McGill University, and in the latter year he joined the staff of the Montreal Water and Power Company as engineer. In 1900 he was appointed chief engineer of the company, holding that office until 1903 when he became general manager and chief engineer. He retired in 1926.

Mr. Pitcher joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on October 9th, 1902, and on October 24th, 1924, became a Member.

PERSONALS

Lieut.-Colonel J. P. B. Dunbar, A.M.E.I.C., formerly engineer officer of Military District No. 5, Quebec, Que., has been appointed to Military District No. 6, Halifax, N.S., as A.A. and Q.M.G.

Lieut.-Commander A. C. M. Davy, R.C.N., A.M.E.I.C., formerly engineer officer (D) Western Division, H.M.C.S. *Skeena*, at Esquimalt, B.C., is now attached to H.M.C.S. *Stadacona*, at the Naval Dockyard, Halifax, N.S.

G. R. Davidson, S.E.I.C., has received his commission as lieutenant in the Royal Canadian Army Service Corps, and is stationed at Wolseley Barracks, London, Ont. Mr. Davidson graduated from the Royal Military College, Kingston, this year.

R. H. Reid, A.M.E.I.C., has joined the staff of Brunner Mond, Canada, Limited, at Toronto, Ontario. Mr. Reid was formerly on the engineering staff of the Beauharnois Construction Company at Beauharnois, Que.

J. C. Aitkens, Jr.E.I.C., who graduated from the University of Manitoba in 1933 with the degree of B.Sc., is with the Water Development Committee at Swift Current, Sask.

J. H. Wallis, A.M.E.I.C., is now manager of the Dominion Engineering Company Limited. He retains the position of general manager of Dominion Hoist and Shovel Company Limited, as well as his interest in Dominion Welding Engineering Company Limited, as director. Mr. Wallis has been engaged in engineering work in Canada since 1910, his early work being land surveys, railway surveys and construction. In August 1914 he enlisted for overseas service as a private with the British Expeditionary Force, and throughout the war served overseas with distinction In July, 1915, he received his commission as lieutenant, in 1916 that of captain and in the following year that of major. Following his return to Canada in 1919, Mr. Wallis entered the service of the Canadian Pacific Railway Company on maintenance-of-way on the International of Maine division. In June, 1920, he was appointed assistant with the Department of Railways in connection with the Grand Trunk arbitration, and later in that year joined the engineering staff of the Canada Creosoting Company in

J. H. Wallis, A.M.E.I.C.

Toronto. Subsequently he was appointed supply engineer with the Riordon Pulp Corporation Ltd., at Temiskaming, Que., and following the acquisition of this company by the Canadian International Paper Company, he was transferred to the construction department in charge of the purchase of equipment and materials for the extension of the mill. Mr. Wallis was later manager of purchasing for the St. Anne Paper Company Limited, and the Murray

Bay Paper Company Limited, resigning that position in 1928 to take over the management of the newly organized Dominion Welding Engineering Company Limited. In 1931 he became general manager of Dominion Hoist and Shovel Company Limited.

H. A. Crombie, A.M.E.I.C., has been appointed assistant manager of the Dominion Engineering Company. Mr. Crombie was educated at Westmount Academy and

H. A. Crombie, A.M.E.I.C.

McGill University, his university course being interrupted by service in France with the Canadian Engineers. He was invalided home in 1917, and resumed his studies, graduating with the degree of B.Sc. in 1918. Mr. Crombie then spent a year on the staff of the Canadian Allis Chalmers Ltd., in Toronto, and was also, for a short time in the service of the Canadian National Railways. He joined the staff of the Dominion Engineering Company when that company was formed in 1920, and in 1933 was appointed sales manager.

Chemical Engineering Congress

The Chemical Engineering Congress of the World Power Conference is to be held in London, England, on June 22nd to 27th, 1936. The holding of an international congress of chemical engineering has been in contemplation for several years, and it has now been made possible by the co-operation of the World Power Conference organization.

The Congress has the support of practically all organations in Great Britain associated with chemical engineering, which substantial support should enable the Congress to be conducted with efficiency and success.

The Canadian Committee of the World Power Conference, of which the chairman is Dr. Charles Camsell, M.E.I.C., will be pleased to facilitate the participation of The Engineering Institute of Canada in the Congress.

This programme is being brought to the attention of the leading chemical industries in Canada with a view to securing appropriate papers. The technical programme may be classified under the following main headings, which, however, does not necessarily indicate the scope of the Congress: Chemical Engineering Projects; Chemical Engineering Plant Construction; Fuel, Heat and General Problems in Chemical Engineering; Administration and Works Organization in Chemical Engineering; Trend of Development in Chemical Engineering, and General Aspects.

CORRESPONDENCE

The Editor,
The Engineering Journal,
Montreal.

Toronto, Ont.
July 25th, 1935.

Sir:—

During this autumn and the coming winter there will, no doubt, be many members of The Institute travelling on business or pleasure throughout Canada. Council has suggested that advantage might be taken of this by asking such members to make arrangements to call on as many branches as their itinerary would permit. Those who assisted in this way could discuss Institute matters or present papers. This applies particularly to those branches so situated that interesting papers are difficult to obtain.

It was felt that much benefit would result from such visits and I am taking the liberty, through The Journal, of asking all members who contemplate trips to communicate either with the General Secretary or with me, giving their proposed itineraries so that the different Branch chairmen concerned may be notified and the necessary arrangements made.

I am, yours faithfully,
(Signed) C. S. L. Hertzberg, M.E.I.C.
Chairman, Papers Committee.
(Room 620, 57 Bloor St. West,
Toronto 5, Ont.)

A Triangulation System for Newfoundland*

Noel J. Ogilvie, M.E.I.C., Director of the Geodetic Survey of Canada.

Following a request from the Commission of Government at Newfoundland, the Canadian government has consented to an arrangement whereby the Geodetic Survey of the Department of the Interior will assist the Island government in laying down two main nets of triangulation as the basis for the survey development of Newfoundland. The completion of the final practical details was reached in Ottawa recently, and the work, it is expected, will extend over a period of five years.

The co-operation of the Geodetic Survey of Canada in this work was discussed in an exchange of correspondence between Sir John Hope Simpson, Commissioner of Natural Resources of Newfoundland, and Hon. Thomas G. Murphy, Canadian Minister of the Interior, and the final details were completed at a conference in the Dominion capital between Dr. A. K. Snelgrove, consulting geologist to Newfoundland's Commission of Government, and the author. Sir John Hope Simpson indicated that two main triangulation nets of about 600 miles total length were believed to be essential as a basis for the Island's orderly survey development; it was considered, however, that Newfoundland would scarcely be justified in creating a geodetic organization sufficiently large to handle an operation of the required magnitude. He therefore inquired if the Geodetic Survey of Canada could assist in the direction of the undertaking.

Canada has a direct interest in this work, as it will complete a circuit of about 1,300 miles of triangulation around the Gulf of St. Lawrence, about 1,000 miles of which are in Canadian territory. One of the Canadian nets extends from the Maritime Provinces as far as Cape Ray at the south-west corner of Newfoundland, while another net, partially completed, follows the north shore of the Gulf of St. Lawrence heading for the Strait of Belle Isle at the north point of the Island. A primary net in Newfoundland connecting Cape Ray and the Strait of Belle Isle, while possibly more than accurate enough for the local requirements of the Island, would obviously strengthen the Canadian nets and hence insure Canadian interest. Apart from the value of the triangulation in the hydrographic charting of the Gulf of St. Lawrence waters, the nets have additional importance, since the Canadian system along the north shore of the Gulf of St. Lawrence passes a comparatively short distance south of a 400-mile stretch of the boundary between the province of Quebec and Labrador, which belongs to Newfoundland; this net must eventually be the foundation for any future boundary action between the two governments.

By Order in Council dated 30th March, 1935, the Canadian government authorized the participation of the Geodetic Survey of Canada in the co-operative effort. The system will be in the form of a T lying on its left side. The top of the T will consist of a 300-mile primary triangulation net from south to north from Cape Ray to the Strait of Belle Isle; the shank of the T will be a secondary east-and-west net of approximately the same length from the primary net eastward to St. John's, the Capital. Canada will supply the technical officers required for the operation, in number estimated at three or four, with such additional officers as may be required from time to time for the measurement of base lines and the observation of Laplace stations. Canada also supplies the instrumental equipment and will make the mathematical reductions and adjustments and publish the results. The Commission of Government of Newfoundland, through the Colonial Development Fund, will pay all other expenses and has provided the sum of $75,000 to cover the estimated cost.

Work will commence during the summer of 1935 and will probably

*Reprinted from the *Empire Survey Review* for July, 1935.

comprise an aerial reconnaissance of the whole net, by methods used with great success in hundreds of miles of Canadian triangulation; there will be one or more ground reconnaissance parties and a station preparation party. The observations can then be commenced in 1936. W. M. Dennis, M.E.I.C., of the staff of the Geodetic Survey of Canada, whose theodolite investigations with J. L. Rannie, M.E.I.C., chief of the Triangulation Division, have been dealt with in the *Empire Survey Review*, will have charge of the field work.

Editor's Note.—It is understood that the Newfoundland work has progressed as noted above. J. L. Rannie, M.E.I.C., and F. P. Steers have completed the aerial reconnaissance for the whole triangulation net. This aerial work is now being ground checked, and two station preparation parties are operating to enable angular measurements to be commenced in 1936. The Geodetic Survey staff in the field at present comprise W. M. Dennis, M.E.I.C., engineer in charge, F. P. Steers and E. M. Medlen.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Mechanical Engineers: Proceedings, Volume 128, 1934.

Reports, etc.

British Standards Institution: Specification No. 610—1935, The Rating of Rivers for Power Purposes.

American Society for Testing Materials: Index to standards and tentative standards, 1933.

Hydro-Electric Power Commission of Ontario: 27th Annual Report, 1934.

Quebec, Bureau of Mines: Annual Report 1933, Part D.

Canada, Department of Labour: Labour Legislation in Canada, 1934.

New Orleans Sewage and Water Board: 70th semi-annual report.

Canada, Bureau of Statistics, Transportation Branch: Preliminary Report on Statistics of Steam Railways in Canada, 1934.

Association of Ontario Land Surveyors: Annual Report 1935.

Technical Books, etc., Received

Manual of Timber Connector Construction. (*Timber Engineering Company, Washington, D.C.*)

Engineering Data on Pipe and Pipe Bends. (*Crane Company Ltd., Montreal.*)

Engineering Data on Flow of Fluids in Pipes and Heat Transmission. (*Crane Company Ltd.*)

Some Considerations and Tests for Cast Materials for High Temperature High Pressure Service, by L. W. Spring. (*Crane Company Ltd.*)

BOOK REVIEW

Engineering Shop Practice—Volume II

By O. W. Boston, John Wiley and Sons Inc., New York. (The Renouf Publishing Company, Montreal) 1935. 6 by 9¼ inches, 485 pages, photos., diagrams, etc. $5.00. Cloth.

Reviewed by PROFESSOR L. M. ARKLEY, M.E.I.C.*

As stated in the preface, this book is a continuation of Volume I, which treats of the basic processes of turning, shaping, planing, drilling, boring, reaming, threading, sawing and milling of metals.

In general the book is well written; each machine and process described is easily understood, especially when reference is made to the very excellent cuts with which the book is generously supplied.

At the end of each chapter is a series of questions designed to test the reader's knowledge of its contents, and in addition to this is a comprehensive bibliography of the subject matter of the chapter.

The headings of the different chapters give a good grasp of the contents of the book. Chapter one treats of screw machines, turret lathes and hand-operated production turning machines.

Chapter two is on automatic turning machines, while chapter three gives an interesting discussion on broaching and the tools required in the process, while chapter four is a comprehensive treatise on the methods of gear cutting.

One of the best chapters in the book is number five on the general subject of surface finishing and describes in detail the processes of grinding, polishing, buffing, honing and lapping.

Chapter six is on the general subject of forming metals into different shapes and includes power and hydraulic presses, punches and dies, and lathes for spinning metals with examples of many processes which may be carried out on these.

The last chapter is devoted to precision measuring instruments including inside and outside micrometer calipers, circular dividing engines, Johansson gauge blocks and many others.

This book has been developed as a text book in connection with the shop courses in the University of Michigan, and as the author states, together with Volume I, they give the background necessary for planning production in machine shops.

The book should be of great value not only to students but to machine-shop superintendents, executives, and anyone connected with the operation of metal cutting machines.

*Professor of Mechanical Engineering, Queen's University, Kingston, Ont.

BULLETINS

Road Maintainers.—The Four Wheel Drive Auto Company, Kitchener, Ont., have issued a 12-page booklet containing particulars regarding the company's models LM and HM road maintainers.

Cement.—A 32-page booklet received from the Portland Cement Association contains data on the cement industry in the United States and also world production.

Pipe Couplings.—A 12-page bulletin issued by the S. R. Dresser Manufacturing Company, Toronto, Ont., contains information on pipe joints manufactured by that company.

Screws.—The Stowell Screw Company, Montreal, have published a 100-page booklet containing a price list of the company's products which include screws, bolts, nuts, rivets, escutcheon pins and metal stampings.

Blowers.—A 4-page folder received from Roots-Connersville Blower Corp., Connersville, Ind., includes information on their Victor-Acme rotary positive blowers for pressure or vacuum service, together with net capacities.

Sheet Piling.—The Canadian Sheet Piling Co. Ltd., Montreal, have issued a 6-page leaflet dealing with the use of steel sheet piling in the construction of the new roundhead, King's dock entrance lock, Swansea, England.

Locomotives.—An 8-page pamphlet received from the Brookville Locomotive Company, Brookville, Pa., describes the company's 2½, 3, 3½, 4, 5 and 6 ton model locomotives, powered with Ford V8 engines.

Compressors.—Four pamphlets received from the Worthington Pump and Machinery Corporation, Harrison, N.J., describe the company's model 105, 160, 210 and 315 gasoline engine driven portable compressors.

Silent Chain Drives.—A 4-page leaflet has been received from the Hamilton Gear and Machine Company, Toronto, Ont., describing and illustrating the "compensation" feature of Hamilton-Ramsey silent chain drives.

The Engineer and His Societies

Extract from an article by Huber O. Croft, appearing in *Mechanical Engineering* for July, 1935.

In any critical examination of the professional responsibilities of an engineer one eventually comes not only to the question of the utility of our engineering societies in promoting the aims and broader aspirations of the individual engineer, but also to the type of engineering organization best fitted to fulfil and satisfy the demands of the individual.

Engineers will be interested to learn that there are at present more than ninety national engineering organizations to represent perhaps two hundred thousand engineers. It should be remembered that practically every one of our national engineering societies has an excellent and extensive organization. It is apparent that there must be an overlapping and duplication of activities of the various groups, not to mention clashes of individual committees attempting to accomplish the identical purpose, but each zealously jealous of obtaining the prestige when the objective has been obtained.

The effect of this confused state of affairs upon the individual engineer is that some societies, such as the Founder Societies have stressed what may be labeled "psychic interest" which may be termed one half of the engineer's circle of activities, paying little attention to the other half, "material interest." Other engineering societies, such as the American Association of Engineers, the National Society of Professional Engineers, and the new born Federation of Architects, Engineers, Chemists and Technicians, have primary interest only in the "material interest" side of his activities.

An engineer knows that if half of the circle of activities is removed the semicircular section remaining is inherently mechanically unbalanced, both statically and dynamically. The same principle may be applied to an engineering organization. No organization which fails to balance psychic or technical interest with professional and material welfare can survive the test of time.

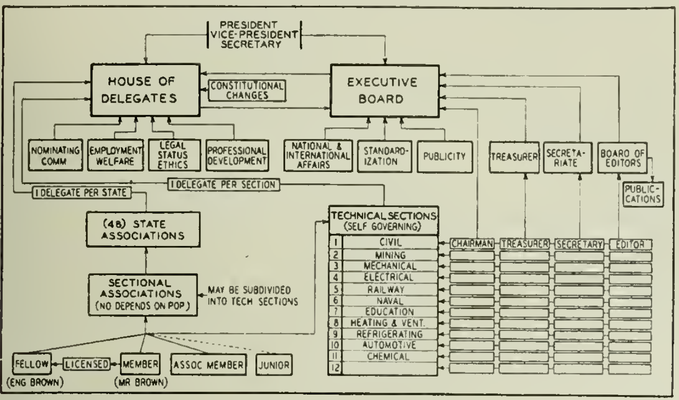
This fact was discovered long ago by the American Medical Association and the American Bar Association. Both of these organizations give suitable attention to both the technical field and the development of professional welfare. The fact that the American Medical Association with a membership of approximately ninety-nine thousand is a flourishing organization should be sufficient stimulus to the engineers of this nation to apply some of their organizing ability to their own profession.

An unbiased engineer considering his societies will recognize two facts: (1) There are too many national engineering organizations, and (2) existing societies should be co-ordinated.

Before suggesting a plan of co-ordination for existing national societies, it is well to consider that steps have been taken to date with this end in view, but so far simplified organization has been confined to the American Engineering Council and the Engineers' Council for Professional Development.

Such co-ordination as these two different groups represent should be supported to the utmost by all members of the profession. It would seem, however, that justified criticisms might be: (1) These organizations are not sufficiently representative, and (2) both the American Engineering Council and the Engineering Council for Professional Development should be branches of the same trunk.

It is with sincere earnestness that a proposed organization chart for a national and rational engineering society is presented below.



The chart is sketchy because it is fully realized that the less appendages attached thereto, the less "deadcats" can be hung thereon.

However it is presented for the discussion and consideration of the engineering profession without comment. Each individual will have his own opinion as to representation, committees, technical sections, and other details.

The four types of membership, "fellow" (a licensed engineer who will be addressed as "Engineer Brown" similar to the custom in Europe and South America), "member" ("Mr. Brown"), "associate member" and "junior" are suggested because of the ease of co-ordination of memberships of existing societies.

Each technical section is self-governing with administrative officers as now exist who become representatives to a committee dealing with the proper interest.

All engineering-society publications pass through the Board of Editors. This in itself might prove of beneficial economic value because of the possible reduced manufacturing costs which might be expected by the proper dispatching of each technical publication through a central plant, either owned or leased by the society to maintain a uniform load curve.

The question of dues is controversial to say the least, but it would seem reasonable to pay dues both to the state group and hence to the national organization, and likewise to as many of the technical sections as might be of interest to the individual.

Steel-Concrete Composite Construction

Steel-concrete composite construction has, during recent years, been applied successfully to numerous buildings and bridges. Since its introduction much valuable technical data has been accumulated, which is now published to assist architects and engineers in preparing designs of composite construction.

In the handbook "Steel-Concrete Composite Construction" recently published by the Dominion Bridge Company Limited, Lachine, Que., and obtainable from that company, the general features of design are discussed and the method of designing composite beams is developed in detail. The uses of special charts and tables which form the body of this handbook are fully explained and are illustrated by typical examples.

Manual of Timber Connector Construction

This manual, published by the Timber Engineering Company, Washington, D.C., presents data on the design and use of connector construction and gives information concerning both toothed and split-ring connectors, and shear plates. Charts and tables of safe working loads for the three types of connectors are given and fabrication and erection notes are developed. Illustrations show a number of interesting examples of modern lumber connector construction. The booklet may be obtained from the publisher at 1337 Connecticut Avenue, Washington, D.C.

Information for 1935 Membership List

Information cards have recently been forwarded to the membership of The Institute requesting the name, present position and address of each member, that the information may be correctly recorded in the new membership list now being compiled.

The completeness and accuracy of this list will be greatly increased if those members who have not already done so will return their cards as soon as possible.

BRANCH NEWS

Peterborough Branch

W. T. Fanjoy, Jr.E.I.C., Secretary-Treasurer.
E. J. Davies, Jr.E.I.C., Branch News Editor.

ANNUAL OUTING

The annual outing of the Peterborough Branch of The Institute was held on Saturday, June 8th, 1935, when forty members motored to Minden, Ont., where they were joined by the members of the Orillia Water Light and Power Commission and the Orillia Town Council. The whole party were the guests of the Dominion Construction Corporation, and the outing consisted of an inspection of Orillia's new hydro-electric power plant at Minden.

This is a half million dollar, two-unit installation, each generator to develop 2,250 kv.a. This plant will replace the present plant at Swift Rapids on the Severn river, which is being supplemented by a block of power from the Hydro-Electric Power Commission of Ontario. When the Minden plant goes into operation Orillia will be one of the few Ontario municipalities with a modern independent power supply. This plant is to go into operation in the very near future.

The guests were welcomed by Mr. A. A. McLaren, A.M.E.I.C., superintendent of the Construction Corporation, who provided every facility for a thorough inspection and enjoyable outing. The visit was concluded by a dinner in the company's dining room provided through the courtesy of the company. Messrs. A. L. Dickieson, A.M.E.I.C., chairman of the Peterborough Branch, and R. L. Dobbin, M.E.I.C., extended the thanks of the guests to Mr. McLaren and his company for their generous hospitality, which made the outing one which would be remembered for a long time.

Saguenay Branch

J. W. Ward, A.M.E.I.C., Secretary-Treasurer.

On Friday evening, June 21st, 1935, G. F. Layne, A.M.E.I.C., gave an interesting paper on "Sugar," dealing particularly with the product obtained from cane.

Sugar is a carbo-hydrate known chemically as sucrose or saccharose. This must not be confused with saccharine, which is a coal-tar derivative.

The refining of sugar was developed by the Egyptians. The Arabs used it in the fourth century, and from them it spread west with the returning Crusaders and East with the various Arab migrations, as far as India and China. Venice was the centre of the sugar trade all through the middle ages.

Spanish and Portugese navigators introduced the cane to the Canary Islands, and to the West Indies about 1525. By 1600 the cane sugar industry was flourishing throughout the West Indies and the demand of this industry for cheap labour was largely instrumental in building up the slave trade.

Sugar cane is a member of the grass family, closely related to the bamboo. It grows only in tropical and sub-tropical countries, and takes about eighteen months to mature. Enormous progress has been made in the improvement of the cane species. Since 1910 the yield has been doubled.

Cane sugar is made by pressing the juice from the ripe cane, the excess water is removed by boiling, until the liquor thickens to the point of crystallization. It is then cooled to form the product known as massecuite, which is shovelled into large hogsheads and allowed to drip. This dripping process goes on for months. Dark crystals remain in the containers, which are known as muscovado. The drippings are known as molasses. The dark crystals are washed with water jets and steam sprays, to produce crystals of much lighter colour known as plantation white. Refinery white sugar is produced from the dark crystals by bleaching with sulphur dioxide or bone coal, and drying in a rotary kiln.

The fuel used to furnish power for the sugar mills consists of the cane after all the juice has been extracted and allowed to dry. This is known as bagasse.

Commercial rum is made from the molasses which contains from 17 to 25 per cent of sucrose. Yeast is used to ferment the sucrose and thereby convert it to alcohol. Great care is exercised in this process, otherwise contamination from the growth of undesirable cultures sets in. Rum comes from the still about 95 per cent pure alcohol and is reduced to about 50 per cent for human consumption. As made rum has a bluish tint. It is coloured by caramel and by storing in burned casks.

Mr. Layne illustrated his talk with a number of slides and diagrams. He also had a number of samples of sugar in its various stages of manufacture, also a section of cane. The sample which aroused the most interest was that of the rum. After the meeting this sample was presented to the chairman, G. E. LaMothe, A.M.E.I.C., who expressed his appreciation in glowing terms.

After considerable discussion the meeting closed with a vote of thanks to Mr. Layne.

Following the address a nominating committee was appointed to make nominations for the new executive for 1935-36. This committee consisted of Messrs. M. G. Saunders, A.M.E.I.C., W. L. Yack, A.M.E.I.C., R. H. Rimmer, A.M.E.I.C., J. W. Ward, A.M.E.I.C., and A. Cunningham, A.M.E.I.C.

The Velox Steam Generator

Abstract of an address given by Adolph Meyer, managing director and engineer in chief of the Brown, Boveri Steam Turbine Works, Baden, Switzerland, in the lecture hall of The Engineering Institute of Canada, Montreal, on July 16th, 1935.

The principal aim in the development of steam producers during the last few years has been to design and manufacture larger units, working at higher pressures and temperatures than in the past.

While new boilers incorporate new and very interesting ideas in the production of steam and the regulation of combustion (the Benson boiler makes use of critical pressure and the Löffler of indirect heating by superheated steam) nothing has been done to improve materially the combustion itself, or the rate of heat transmission.

It is in relation to these last two points that the Velox boiler differs essentially from most boilers which have been in use up to now. Its name, "Velox," refers to the high velocity of the flue gases, which are used to obtain exceptionally high heat transmission. The main features of this new boiler are as follows:—

(1) Combustion takes place under a pressure far in excess of that generally employed.

(2) Partial transformation of the above pressure into velocity, in order to obtain high flue gas speed. This speed may reach the velocity of sound.

(3) The use of a turbo-blower, worked by an exhaust gas turbine, in order to produce the pressure in the combustion chamber referred to in (1) above.

(4) Disposition of the gas turbine between two heat-absorbing parts of the boiler, in order to reduce the temperature of the flue gases so that cooling of the turbine is unnecessary, but also permitting of sufficient heat being left in the gas to provide the necessary energy for driving the turbo-blower. The heat which remains is passed on through the feed-water heater section or sections of the boiler following the gas turbine.

(5) A special device for separating steam from water which consists of a centrifugal separator without moving parts, in which the mixture of steam and water is injected tangentially on to the cylindrical wall of a container at such a velocity that it rotates with sufficient force to separate the steam and water by centrifugal action.

(6) The very small weight of steel and water taking part in the heat transmission which, together with the entire absence of fire bricks and the small storage of water which is necessary, allows for rapid starting of the boiler and gives very flexible operation under variations of load.

(7) Forced circulation in the evaporating part of the boiler.
(8) Entirely automatic governing.
(9) Small weight.
(10) Small space requirement.
(11) High efficiencies over large variations in load.

These advantages have been obtained by the process of "supercharging," which is common practice in diesel work and are even greater when applied to a boiler, for, in addition to reduction in the size of the combustion chamber, the size of the heat transmitting system is reduced twofold; both by higher pressure as well as by higher speed of the flue gases.

In determining the practical range of velocities to be employed in the Velox boiler, it was soon found that to compensate for the higher expenditure on pressure-tight combustion chambers, and the pressure-producing machinery, a radical departure from accepted practice was necessary and velocities ranging from 900 feet per second to 450 feet per second have been adopted for the evaporator tubes: lower, but still unusually high velocities, being used in feedheater and superheater. All these parts have therefore to be built "streamlined" so as to reduce pressure losses as much as possible.

Figure 1 represents a steam generator of the Velox type, and a diagram shows the temperatures and pressures prevailing in its different parts. The combustion of the fuel takes place in the combustion chamber 2 where air and fuel enter through the burner 1, the air under a pressure of about 35 pounds per square inch absolute, the fuel under about 300 pounds gauge. The gases give up part of their heat content by radiation through the external walls of the evaporator tubes 3, which line the wall of the combustion chamber. More heat is transmitted by convection, while the gases pass upwards, through the internal tubes 3A of the evaporators to the exhaust flue gas collecting chamber. Thus the initial temperature of combustion is reduced to about 1,500 degrees F., while the pressure drops to about 33 pounds absolute. With this temperature and under this pressure the gases enter the superheater 5, to leave it cooled down to about 900 degrees F. at a pressure of about 31 pounds. The gas turbine 6, which is then entered, causes the flue gas temperature to drop to about 700 degrees F. while the pressure drops to about 16.5 pounds absolute. The corresponding heat drop is, apart from very small radiation and bearing losses, entirely converted into mechanical energy and transmitted to the blower where it is reconverted into heat with a corresponding rise in the air temperature. Finally, the gases escape through the feed-water heater 7 which forms part of the chimney. From thence they continue, through the chimney 8 itself, to the atmosphere, where they leave cooled down to about 200 degrees F.

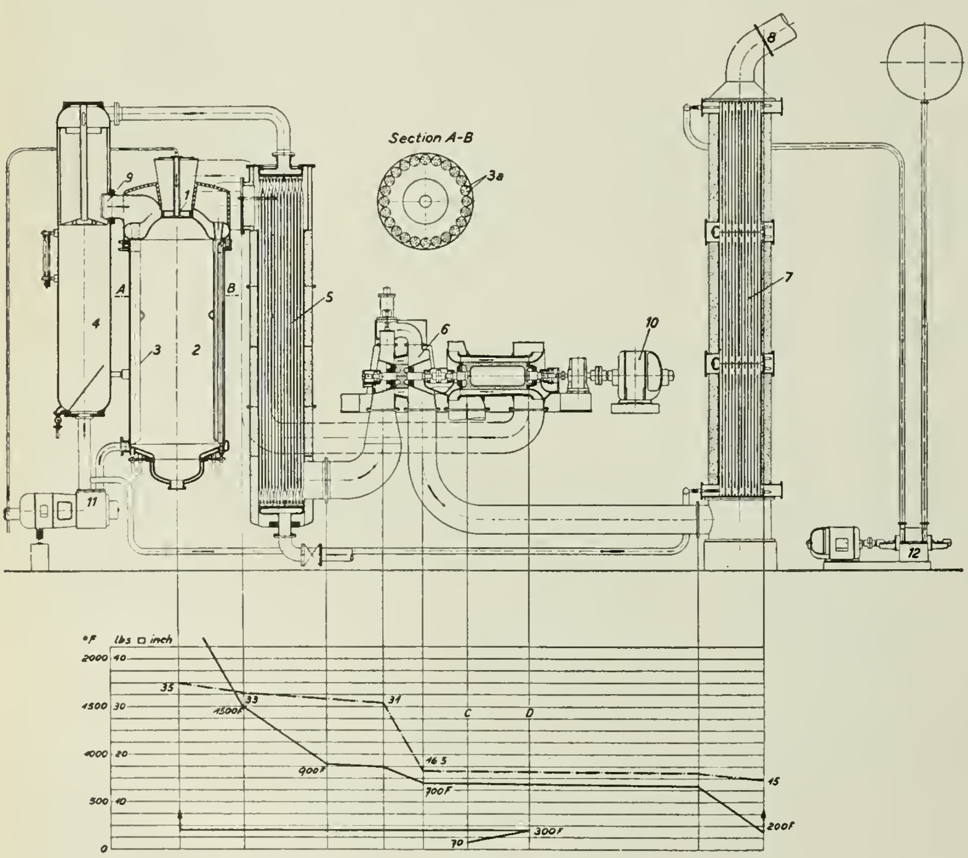


Fig. 1—Diagram of Velox Steam Generator showing Temperatures and Pressures in Various Parts of the Apparatus.

The water and steam circuit is as follows:—

The make-up water is fed by the feed pump 12 through the preheater 7 to the separator 4, where it mixes with the evaporating water. This water is kept in continuous circulation by the circulating pump 11, which pumps it through the combustion chamber 2 and evaporating tubes 3 back to the separator 4, at the rate of about ten times the full load evaporation.

The water enters the separator through the nozzle 9 tangentially to its wall. This nozzle has the smallest sectional area of any tube in the circuit so that a sufficiently high pressure builds up in the tube before the water reaches the nozzle. This pressure is converted into velocity, and the mixture of water and steam spins round on the inside of the cylinder. The water then falls through a small gap in the lower partition of the separator, while the steam is pressed out to the centre and enters the superheater 5, where it is superheated up to the desired amount for use in a steam turbine.

The automatic governing system is shown in Fig. 2. In principle the system is similar to that employed by Messrs. Brown Boveri on their turbines for the last twenty years. The different devices for maintaining the feed-water level, governing the amount of oil and air, are shown respectively by *A*, *B* and *C* of Fig. 2. An oil pump, connected to the motor driving the circulating pump already mentioned, supplies oil through the pipe 13 to the different governors. A plug 12 reduces the pressure in a variable degree according to the position of a leak-off valve 14. In *A* the position of this valve is governed by a water column acting against a spring, so as to keep the water level constant by varying the pressure beneath the piston 15 which governs the feed valve 12.

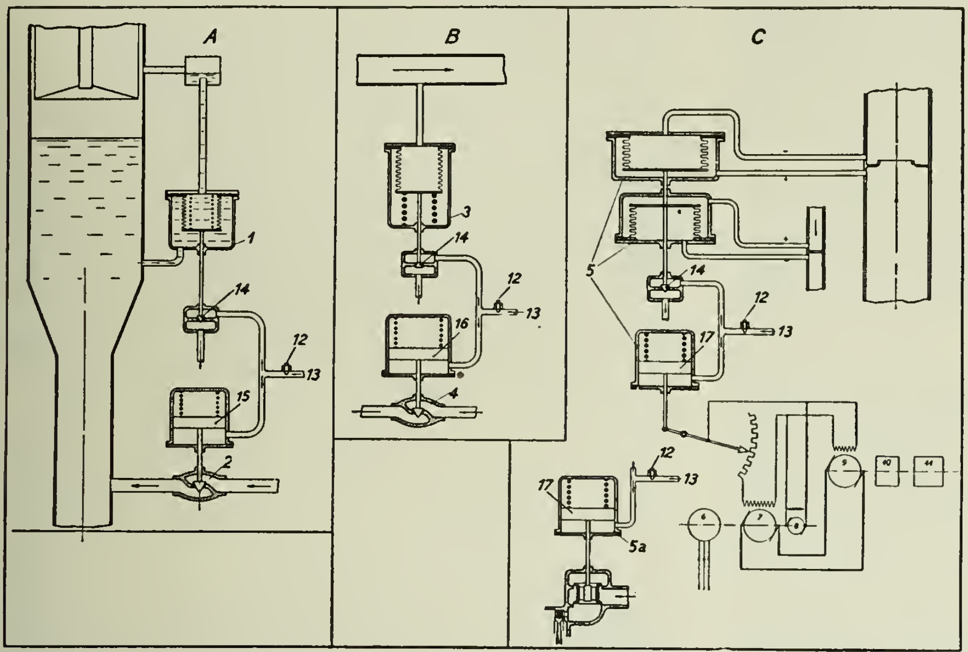


Fig. 2—Outline of Automatic Governing System *A* Quantity of Feed Water and Water Level, *B* Quantity of Fuel and *C* Quantity of Air.

In the governing system *B*, regulating the amount of fuel oil, the leak-off valve 14 is governed by the pressure of the steam in such a way that with a falling steam pressure the valve is shut so as to raise the oil pressure under piston 16, thus opening the fuel valve 14. The governing system *C* tends to establish a constant ratio between the amount of fuel and the amount of air; both the fuel valve and the air valve work on the same leak-off valve 14, and maintain their relative

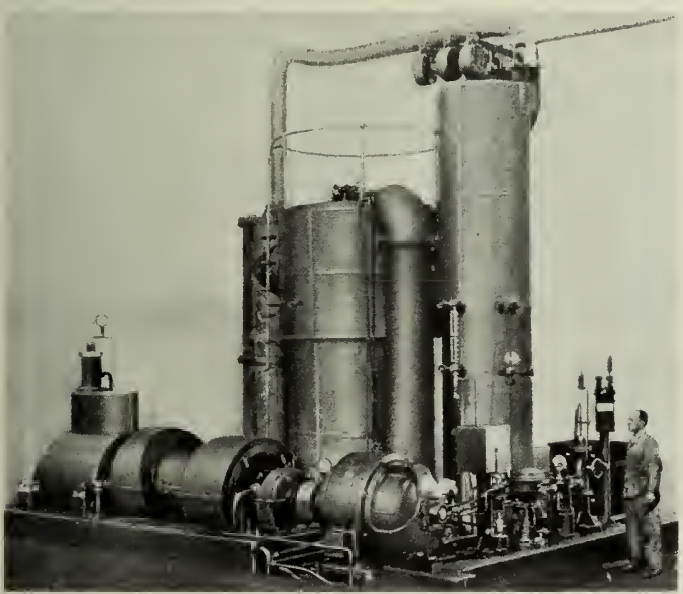


Fig. 3—Velox Steam Generator with Governing System on Test Bed.

positions as long as the ratio of the two is constant. Any deviation from this ratio displaces valve 14 with a corresponding change in the oil pressure beneath the piston 17, adjusting the power of the auxiliary drive which may be an electric motor or a turbine.

If, for instance, more fuel oil is introduced owing to a fall in steam pressure by the system *B*, the auxiliary motor accelerates the supercharging set so as to get more air through. This is only necessary until stable conditions are again established by the increased pressure and temperature at the gas turbine, with a corresponding increase of power from that unit.

Owing to the small amount of material taking part in heat transmission, and to the small water storage capacity, the boiler can be set to work in an unusually short space of time. Steam pressure, temperature and quantity can be raised to full load conditions in less than five minutes. The same applies to load variations, which are so rapidly dealt with by the automatic governing system, that variations from half to full load and vice versa take only about twenty seconds.

As a Velox boiler is more a kind of steam-producing machine than a boiler, the whole unit can easily be erected and tested at the manufacturer's works. This has allowed tests to be made under normal working conditions, of which the following is an example carried out on an oil-fired boiler.

The steam generator, with its governing system, is shown on the test bed in Fig. 3 and gives a good impression of the small space requirements of such a boiler. The boiler was constructed for

A capacity of 55,000 lbs. per hr.
A steam pressure of 284 lbs. per sq. in.
A steam temperature of 700 deg. F.

Particulars of this boiler are as follows:—

Total evaporator heating surface	624 sq. ft.
Superheater heating surface	645 sq. ft.
Economizer heating surface	1,720 sq. ft.
Total	2,989 sq. ft.
Combustion chamber volume	124 cu. ft.
Steam production on test	62,320 lbs. per hr.
Evaporation from evaporator heating surface	100.0 lbs. per sq. ft.
Evaporation from total heating surface	30.0 lbs. per sq. ft.

The boiler efficiency, including allowance for the power absorbed by all auxiliaries exclusive of the feed pump, was 90.85 per cent. The exhaust pipe, being relatively long and of insufficient diameter, caused the back pressure to be 22-inch water gauge instead of 2-inch for which pressure it was originally designed and operated on site. Under normal working conditions the efficiency will approach 92.5 per cent in place of 90.85 per cent achieved. (See Table I.)

Table I

Test Results of 25 Tons Per Hour Velox Steam Generator. Toulon.

Test No.		1	2	3	4
Load		¼	¾	4/4	Overload
Fuel			Mazout		
Calorific value (net)	B.t.u./lb.	17,940	17,820	17,810	17,950
Quantity	lb./hr.	1,078	3,162	4,340	4,578
Air quantity	lb./hr.	19,960	50,600	69,850	71,400
Excess air ratio		1.29	1.10	1.11	1.06
Gas temperature leaving economizer	deg. F.	192	228	257	253
Steam—					
Quantity	lb./hr.	14,690	42,290	57,840	62,320
Pressure leaving superheater	lb./in²g.	276	285	281	283
Temperature leaving superheater	deg. F.	582	673	714	707
Feed-water inlet temperature	deg. F.	140	141	146	143
Electric Power—					
Power absorbed by all auxiliaries	kw.	48.4	73.6	157.6	174.8
Efficiency based on net calorific value—					
Without auxiliaries	per cent	90.3	93.1	93.8	95.0
With auxiliaries	per cent	86.8	91.2	90.8	92.1

The features of the Velox steam generator make it also suitable for use on board ship and for traction purposes, especially if high speeds are aimed at.

In stationary plant its use is somewhat limited owing to the necessity for using liquid or gaseous fuel, but tests which have been made show that the adaptation of the Velox steam generator to pulverized fuel may be possible in the near future.

The Loeffler System of Steam Production

Abstract of a paper by S. McEwen published in the November 16th, 1934, issue of *The Engineer*.

While the combustion engineer is constantly striving to obtain higher furnace temperatures in order to secure the benefit of a high rate of heat transmission consequent with a higher heat head, the steam engineer, pursuing a definite course of development, provides higher internal temperatures so that the result of both these efforts is to subject the material of heating surfaces to conditions of greater severity. The following account of the Loeffler system, however, will show how the new conditions have been effectively met without making exceptional demands on the metallurgist.

Prominent engineers have expressed their views as to highest practical limits of steam temperature and pressure under present-day conditions and it seems to be most generally accepted that considerations of capital cost, maintenance charges and reliability make it unprofitable to employ steam for power generation at pressures above 600 pounds per square inch and temperatures above 800 degrees F. This conclusion is, of course, based on the assumption that water-tube boilers would have to be used for the generation of steam, and ignores the more recent developments in turbine design, which latter have established in commercial practice the complete practicability of the use of pressures and temperatures such as are adopted in the Loeffler system.

Calculations show that with steam at a pressure of 590 pounds per square inch and a temperature of 842 degrees F., the steam consumption per kilowatt generated is 11.7 per cent greater than with steam at a pressure of 1,900 pounds per square inch and a temperature of 896 degrees F. For the purpose of this comparison it has been assumed that with the lower pressure there is no economic advantage in inter-stage reheating, but steam would be bled from the turbine in two stages to heat the feed water to 302 degrees F. Under the Loeffler conditions of higher pressure, reheating is adopted, and steam leaving the first stage of the turbine is reheated by means of a heat exchanger from 537 degrees to 662 degrees F. For preheating the feed water steam is withdrawn from the turbine in three stages, raising the temperature of the feed water to 392 degrees F.

This increased degree of preheating by means of bled steam is warranted by the higher boiling point of the water at the higher pressure. The boiling point of water of 590 pounds pressure is 486 degrees F. whereas at 1,900 pounds pressure it is 623 degrees F. The comparison allows for a higher power consumption for auxiliary plant with the Loeffler system.

Figure 1 is a diagrammatic representation of the Loeffler system. Referring to this diagram, S is a radiant superheater, lining a combustion chamber; N is a convection superheater; B is a boiler drum

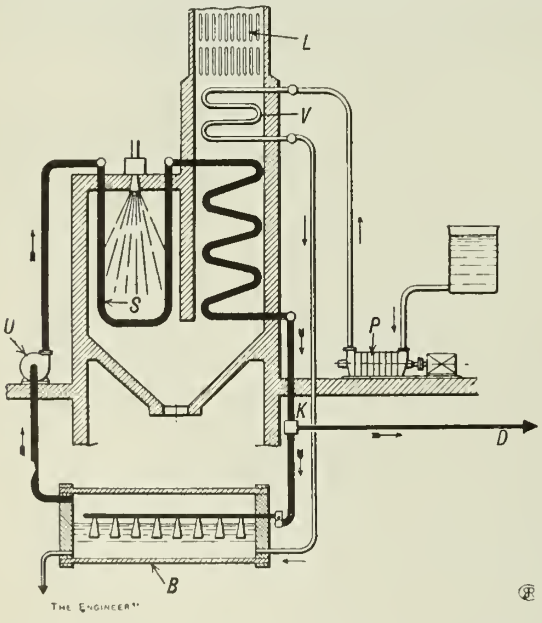


Fig. 1—Diagrammatic Representation of the Loeffler System.

placed in any convenient position outside the setting; U is a rotary pump, the purpose of which is to circulate steam, withdrawn from the boiler drum through the radiant and convection superheaters up to the branch K, at which point a part of the steam passes to the steam mains while the remainder returns to the boiler drum wherein its superheat is utilized to evaporate more water, the amount to be evaporated being equivalent to that delivered to the steam main. P is a feed pump, while V and L represent the economizer and air-heater respectively. It will be observed that one outstanding feature of the system is that all the steam is generated in a drum not exposed to any external heat, while the remainder of the circuit which is exposed to external heat contains only dense, clean and dry steam.

Steam at a pressure of 1,900 pounds per square inch has a specific volume of 0.21; whereas at a pressure of 600 pounds per square inch the specific volume is 0.76; the density at the higher pressure is three and one half times greater than at the lower. It is this low specific volume which makes it economically possible to circulate the steam by means of a pump.

The successful achievement of the commercial generation of steam at high pressures and temperatures by the Loeffler system has been secured in virtue of four main characteristics of the system.

Steam is the only medium for absorbing the heat which is liberated in the furnace, and this steam in a very dense condition is caused to flow through tubes at a velocity which ensures a small differential in temperature between that of the steam and the metal walls of the tubes. This differential, which can be predetermined by calculation, is such that the metal of the tubes of selected quality can suffer no deterioration. The velocity of the steam, which can be predetermined for any installation, is of the order of 65 feet per second at maximum capacity, and, under these conditions, over 40,000 B.t.u. are transmitted per square foot of heating surface per hour through the surface of the radiant superheater without any risk of overheating the metal.

The entire absence of scale or deposit on the interior surfaces of the tubes ensures constant condition for heat transference; no provision has to be made for a progressively reduced rate of transference, as is the case with a water tube boiler, where the maximum allowable rate of transference must be that which is safe when the tubes are dirty and the boiler due for internal cleaning.

There being an entire absence of water circulation problems, the disposition of the heating surface can be arranged with consideration only for heat transmission. The tubes not being subject to the necessity for internal cleaning, can be disposed without regard to provision for cleaning. The high average rate of heat transmission which is actually obtained in practice, results in a material reduction in the area of heating surface which has to be provided for any given duty as compared with that required for a normal water tube boiler. This reduction in area more than balances any extra expense per square foot of heating surface involved, in providing for higher pressures. In comparing modern Loeffler installations with modern water-tube boiler installations, it is found that the latter have from 40 to 50 per cent more pressure heating surface than the former.

It will be readily apparent that by the Loeffler principle of steam generation, the condition of the feed water becomes a matter of minor importance. Thus it becomes possible with the Loeffler system to obtain the economic advantages of high pressure and high temperature steam applied to back pressure turbines furnishing exhaust steam for industrial process. In such cases the make-up water may be 100 per cent, and this presents no difficulty. It is, of course, desirable to deaerate the feed water, and where it is possible it is preferable to subject the feed water to chemical treatment in order to avoid unnecessary blow-down losses. The practicability of operating the boiler with a high concentration of solids has been established by very carefully conducted and complete tests.

In practically every case in which the Loeffler is being examined for the first time, attention is focussed on the steam circulating pump. The pump is quite simple in construction, consisting of a single impeller, which rotates within a heavy steel housing.

Figure 2 shows the complete pump unit. The impeller shaft is fitted with labyrinth gland. This gland is entirely effective and may be seen with the steam channels with which it is provided. If saturated steam from the pump housing were allowed to pass through the gland, some condensation would occur which would cause erosion of the fins of the labyrinth. To obviate this, high pressure steam drawn from the radiation superheater, at a temperature of 770 degrees F. enters at A and passes to the gland near the impeller. Part is withdrawn at B at a pressure of about 190 pounds per square inch, and is conducted to the steam inlet of the turbine driving the pump. The remainder of the steam from the gland escapes at a little above atmospheric pressure, and is used for preheating the feed water.

One of the incidental functions of the pump, which, nevertheless, has a very definite value, is to remove by centrifugal action any moisture which may be carried over with the saturated steam leaving the evaporating drums. Ports provided at the periphery of the housing collect such moisture, which automatically flows back to the drum, the pressure in the housing being greater than that within the drum. The main purpose of the pump, however, is to circulate steam at the desired velocity through the system and by variations in that velocity to maintain a uniform final temperature of steam for delivery to the turbine. The ability of the pump to secure this result by simple speed control may be readily understood when it is appreciated that a given quantity of heat transmitted through the heating surface may be absorbed in a large quantity of steam at a low temperature or in a smaller quantity at a higher temperature. The pump provides the means for varying the quantity at will and instantly so that it is possible to maintain a constant temperature at the expense of a variation in quantity. Variations in demand for total heat must ultimately be met by combustion control. Combustion control is a necessity, owing to the number of factors involved, somewhat low, and the Loeffler boiler, in virtue of the steam-circulating pump, is much more

(*Continued on page 440*)

Preliminary Notice

of Applications for Admission and for Transfer

August 10th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in October, 1935.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

SANDWELL—PERCY RITCHIE, of 139 Brock Ave. South, Montreal West, Que., Born at London, England, Oct. 26th, 1912; Educ., B.A.Sc. (Mech.), Univ. of B.C., 1935; Summers: 1927-28, machine shops, Powell River Co., Powell River, B.C.; 1929, highway survey, B.C. Govt.; 1930-31, timekeeper and surveyor's asst., erection dept., Dom. Bridge Co., Vancouver; 1933, constrn. gang, Powell River Co.; 1934 (4 mos.), dftsman., and at present, dftsman., paper machy. dept., Dominion Engineering Works Ltd., Montreal, Que.

References: R. Bell-Irving, A. S. Gentles, J. Robertson, A. C. R. Yuill, J. F. Bell, E. A. Wheatley, W. Jamieson.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BEAM—DONALD CARLETON, of 191 Castlefield Ave., Toronto, Ont., Born at Stevensville, Ont., Aug. 21st, 1899; Educ., B.A.Sc., Univ. of Toronto, 1928; Summers: 1923, instr'man., J. W. Cowper Constrn. Co., Buffalo, N.Y.; 1924, layer-out, steel shops, Jones & Laughlin Steel Corpn. Ltd., Penna.; 1925, asst. to mining engr. Castle Tretheway Mines Ltd., Gowganda, Ont.; 1926 to 1927, in charge of survey party on trans. line location and prelim. survey, Shawinigan Engrg. Co. Ltd., Montreal; 1928 to date, struct'l. engr., checking design of all types of steel and concrete structures, for bldg. dept., City of Toronto, Toronto, Ont. (*St. 1926, Jr. 1927.*)

References: G. C. Hoshal, R. E. Smythe, J. J. Spence, P. M. Thompson, G. L. Wallace, J. M. Oxley.

JACKSON—CHARLES H., of Brownsburg, Que., Born at Toronto, Ont., June 2nd, 1901; Educ., B.A.Sc., Univ. of Toronto, 1923; 1919-23 (summers), Dept. Public Highways, Ontario; 1924, clerical work and field engrg., Detroit; 1924, instr'man., Rouen, Que.; 1924-25, instr'man., paper mill constrn. for Price Bros. & Co. Ltd., Riverbend, Que., and 1925, installn. of equipment in above; 1926, field engr., paper mill constrn., Man. Paper Co. Ltd., Pine Falls, Man.; 1926-28, asst. supt., extension of Riverbend mill, Price Bros. & Co. Ltd.; 1928-29, architect's supt. on constrn. of Dominion Square Bldg., Montreal; 1929 to date, with Canadian Industries Limited, as follows: 1929-32, misc. civil engrg. for constrn. of new plants and additions and alterations to existing plants; 1933, study of manufacture of ammunition and blasting caps; 1934 to date, production manager of ammunition divn., in charge of manufacture of ammunition, blasting caps, etc., Brownsburg, Que. (*Jr. 1928.*)

References: L. deB. McCrady, A. B. McEwen, I. R. Tait, D. J. Emrey, W. H. Keith.

MOORE—ALEXANDER GLYDON, of 1514 Crescent St., Montreal, Que., Born at Hazelbrook, P.E.I., Mar. 2nd, 1902; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1925; 1925-27, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.; 1927 (3 mos.), trans. engrg. and constrn., Bell Telephone Co.; 1928 (4 mos.), Arthur Surveyer & Company, appraisal, Shaw. Water & Power system; 1927-28, asst. elect'l. supt., Asbestos Corpn., Thetford Mines layout, design and installn. for new mill, gen. constrn. and mtce.; 1928-30, asst. engr., constrn. and mtce., overhead distrn. system, Shawinigan Water & Power Co., Shawinigan Falls, Que.; 1930 to date, asst. supervisor, underground elect. distrn., Montreal Light Heat & Power Cons., Montreal. (*St. 1923, Jr. 1930.*)

References: G. R. Hale, L. L. O'Sullivan, R. N. Coke, H. Milliken, G. E. Templeman.

WILLIS—REUBEN WESLEY, of 373 Castlefield Ave., Toronto, Ont., Born at Gowanstown, Ont., Oct. 24th, 1900; Educ., B.Sc., Queen's Univ., 1927; Summers: 1923-26, engr's. asst., Geodetic Survey of Canada; 1927-29, struct'l. steel dftsman and checker, Canadian Bridge Co., Walkerville; 1929 to date designing bridge engr., Dept. of Works, City of Toronto, Toronto, Ont. (*Jr. 1929.*)

References: T. Taylor, F. Stevens, A. Macphail, W. P. Wilgar, A. B. Crealock, D. T. Alexander, H. W. McAll, D. S. Ellis.

WRANGELL—KJELL FREDERICK, of Ottawa, Ont., Born at Kristianssands, Norway, June 11th, 1902; Educ., 1920-22 (day classes), Horten Technical School; 1924-26, filing, tracing, dfting., Riordon Pulp Corpn., Temiskaming, Que.; 1926-27, Solvay Process Co., Solvay, N.Y., dfting. and estimating; 1927 (Sept.-Dec.), supt., mtce., International Fibre Board Ltd., Midland, Ont.; 1928-29, designing, estimating, dfting., Link-Belt Ltd., Montreal; 1929 to date, mech. engr., designing, appraising, estimating, etc., The E. B. Eddy Co. Ltd., Hull, Que. (*Jr. 1931.*)

References: W. S. Kidd, L. S. Dixon, J. C. Day, P. N. Libby, A. N. Ball.

FOR TRANSFER FROM THE CLASS OF STUDENT

ELLIOTT—LISGAR WEBSTER, of 301 Brookfield Ave., Town of Mount Royal, Que., Born at Merrickville, Ont., July 15th, 1908; Educ., B.Sc. (E.E.), Univ. of Alta., 1933; Summers: 1928, C.N.R. bridge constrn.; 1929-32, City of Edmonton engrg. dept.; March 1935 to date, engr., receiver development, Canadian Marconi Co. Ltd., Montreal, Que. (*St. 1933.*)

References: R. J. Gibb, C. A. Robb, R. S. L. Wilson, H. J. MacLeod, H. L. Seymour.

LEGG—JOHN HERBERT, of 712 Jefferson Apts., Niagara Falls, N.Y., Born at Victoria, B.C., Apr. 9th, 1905; Educ., B.Sc., McGill Univ., 1929; 1922-25 (20 mos.), operator, Triangle Chemical Co., New Westminster, B.C.; 1926-27 (8 mos.), mill shift boss, Engineer Gold Mine, Atlin, B.C.; 1929 (4 mos.), mine sampler, Allihies Copper Mine, Co. Cork, Ireland; 1929 (8 mos.), asst. mill supt., Tetrault Mine, Que.; 1930 (8 mos.), asst. mill supt., Stirling Mine, N.S.; 1930-32, metallurgist, Flin Flon Mine, Man.; 1933 (June-Aug.), asst. mgr., Can. Malartic Gold Mine, Que.; 1933-34, mill supt., Aldermac Mines Ltd., Arntfield, Que.; Jan. 1935 to date, representing Aldermac Mines Ltd. on "Sulphur Process" at Comstock & Wescott Inc., Niagara Falls, N.Y. (*St. 1927.*)

References: C. S. Gzowski, S. C. Mifflen, C. M. Anson, W. H. Powell, A. Stansfield.

McKAY—ROBERT DONALD, of Yarmouth, N.S., Born at Yarmouth, June 13th, 1908; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1933; 1930 (June-Oct.), student asst., Geol. Survey of Canada; 1930-31, engr.'s helper, Parsons Constrn. Co., Yarmouth; 1931 (Apr.-Sept.), instr'man., and paving inspr., Town of Yarmouth; Aug. 1934 to Jan. 1935, res. engr., Dept. of Highways, N.S.; Feb. 1935 to date, post-graduate course in sanitary engrg., Graduate School of Engrg., Harvard University. (*St. 1932.*)

References: W. P. Copp, F. R. Faulkner, S. Ball, J. K. McKay, H. R. Theakston, H. W. L. Doane.

MOFFAT—THOMAS STUART, of Saint John, N.B., Born at Victoria, B.C., Feb. 14th, 1905; Educ., B.Sc. (E.E.), McGill Univ., 1927; 1922-25 (summers), machinist's helper; 1926 (summer), electrn., Aluminum Co. of Canada; 1927-28, student's training course, and 1928-29, elect'l. substation design, Canadian Westinghouse Co.; 1930 (Jan.-Nov.), engr., automatic telephones, and 1930-32, engr., gen. mfg. dept., Northern Electric Co.; 1933-34, industrial engr., Simonds Canada Saw Co.; 1934-35, industrial engr., Management Engineers of Canada; Mar. 1935 to date, supt., Provincial Wood Products Co., Saint John, N.B. (*St. 1925.*)

References: J. R. Dunbar, E. M. Coles, S. R. McDougall, J. F. Plow, C. V. Christie, W. H. Eastlake.

NICOLAISEN—JUNCKER ZELO, of Beauharnois, Que., Born at Elsinore, Denmark, Nov. 15th, 1907; Educ., B.Sc. (E.E.), Univ. of Durham, England, 1929; 1928 (summer), student, Clarke Chapman, Gateshead-on-Tyne; 1929 (Oct.-Dec.), dftsman., Jan. 1930, students test, Can. Gen. Elec. Co.; 1930-31, electrician, 1931-32, engr., Beauharnois Construction Co.; Oct. 1932 to date, asst. elec. engr., Beauharnois Light Heat & Power Co., Beauharnois, Que. (*St. 1920.*)

References: B. K. Boulton, M. V. Sauer, L. H. Burpee, F. H. Cothran, C. H. Pigot, C. G. Kingsmill.

PEEBLES—ARCHIBALD, of 2911 West 15th Ave., Vancouver, B.C., Born at Glasgow, Scotland, July 23rd, 1904; Educ., B.A., 1929, B.A.Sc. (Civil), 1934, Univ. of B.C.; 1920-23, struct'l. dftsman., Can. Northwest Steel Co.; 1924-29 (vacation periods), dftsman. on constrn. work with various firms; 1929-31, struct'l. dftsman. and checker, Dominion Bridge Co., Vancouver; 1931 to date, instructor, Dept. of Civil Engrg., University of British Columbia, Vancouver, B.C. (*St. 1927.*)

References: A. S. Gentles, W. H. Powell, A. S. Wootton, P. H. Buchan, P. Sandwell, J. Robertson, A. E. Foreman.

RHODES—DONALD, of 99a Portland Ave., Sherbrooke, Que., Born at Baildon, Yorks., England, Mar. 27th, 1907; Educ., B.Sc., McGill Univ., 1928; 1926 (summer), elect'l. wiring, St. Narcisse Power House, Shawinigan Water & Power Co.; 1927 (summer), plant inventory, North Shore Power Co.; 1928-31, asst. field engr., 1931-34, divn. transmission engr., and 1934 to date, district engr., Sherbrooke District, Bell Telephone Co. of Canada. (*St. 1926.*)

References: J. L. Clarke, G. A. Wallace, C. V. Christie, L. G. Buck, W. L. R. Stewart, W. J. S. Dormer, L. E. Ennis, D. H. McDougall.

RODGER—NORMAN ELLIOTT, of 221 Gladstone Ave., Ottawa, Ont., Born at Amherst, N.S., Nov. 30th, 1907; Educ., B.Sc. (Civil), McGill Univ., 1930. Grad., R.M.C., 1928; 1930-31, School of Military Engrg., Chatham, England; 1928-29, asst. to works officers, Major G. R. Chetwynd, R.C.E., A.M.E.I.C., Halifax, N.S.; 1932-33, asst. to Officer i/c Geog. Section of the General Staff, National Defence Headquarters, Ottawa; at present attached to the General Staff, National Defence Headquarters, Ottawa, Ont. (*St. 1930.*)

References: E. J. C. Schmidlin, G. R. Turner, A. G. L. McNaughton, E. L. M. Burns, L. F. Grant.

ROSS—WILLIAM BRUCE, of 367 Metcalfe Avenue, Westmount, Que., Born at Westmount, Sept. 25th, 1905; Educ., B.Sc., 1930, M.Sc., 1931, Ph.D., 1933, McGill Univ.; 1925, instr'man., photographer, computer, Back River Survey with W. I. Bishop, M.E.I.C.; 1925-27, successively in test room, experimental dept., and as technical asst. to asst. chief engr., Canadian Marconi Co., Montreal; Research work as follows: 1930-31, on dielectric constants, 1932-33 on Heaviside and Appleton layers, 1931 to date, on air flow and sound; 1932, in charge of McGill-National Research Council party to Nfld. to investigate radio effects of solar eclipse; 1932 to date, lecturer in mathematics, McGill University, also continuing experimental work on sound measuring apparatus. (*St. 1929.*)

References: E. Brown, C. V. Christie, G. J. Dodd, J. H. Thompson, F. M. Wood.

SHEARWOOD—ALEXANDER PERRY, of Montreal, Que., Born at Montreal, July 8th, 1908; Educ., B.A., 1930, B.Eng., 1932, McGill Univ.; 1927-28 (summers), detailing, Dominion Bridge Co.; 1929-30 (summers), bridge dept., C.P.R.; 1931, visited struct'l. steel works in Great Britain, Germany and France; 1932-33, ap'tice in various depts., 1933-34, asst. engr., tests of special Hopper cars on C.N.R., and responsible for sales of National Boat Builders, Montreal; 1934 (Apr.-Sept.), asst. engr., Coverdale & Colpitts, New York, on inspection and preparation of report on existing rolling stock, Chicago, Milwaukee, St. Paul & Pacific, in Pacific northwest; at present, asst. engr., National Steel Car Corpn., Montreal, Que. (*St. 1929.*)

References: E. Brown, W. W. Colpitts, A. R. Ketterson, F. P. Shearwood, J. M. R. Fairbairn.

SKELTON—CECIL HASTINGS, of Three Rivers, Que., Born at Montreal, Que., June 15th, 1908; Educ., B.Sc. (Mech.), McGill Univ., 1930; 1927-28 (summers), dfting., Steel Co. of Canada; 1929 (summer), inspr. and mechanic, General Motors of Canada, Oshawa; 1930-31, cadet engr., Bailey Meter Co., Cleveland; 1931-32, research, dept. of chemistry, McGill Univ., for Noranda Mines Ltd.; 1932-34, field engr., in charge of constrn. and operation, Nichols-Freeman Flash Roaster, at St. Lawrence Paper Mills Co., and 1934-35, test and reconstrn. work on same plant for same company; Feb. 1935 to date, field and lab. work, as research engr., for Consolidated Paper Corpn., Three Rivers, Que. (*St. 1929.*)

References: H. O. Keay, F. W. Bradshaw, E. Brown, C. M. McKergow, E. C. Kirkpatrick.

THOMPSON—FRANK LAWRENCE, of Dartmouth, N.S., Born at Moncton, N.B., Oct. 21st, 1905; Educ., B.Sc., N.S. Tech. Coll., 1932; 1932 to date, with the Imperial Oil Refinery Ltd., Dartmouth, N.S., from 1934-35, technical service engr., Technical Service Divn., Maritimes and Nfld. (*St. 1930.*)

References: R. L. Dunsmore, R. R. Murray, F. R. Faulkner, C. H. Wright, H. Fellows.

TREMAIN—KENNETH HADLEY, of Toronto, Ont., Born at Windsor, N.S., Mar. 7th, 1905; Educ., B.Sc. (Elec.), McGill Univ., 1929. Grad., R.M.C.; 1929-32, mechl. and engrg. dept., paper mill, Can. Power & Paper Co.; 1933 to date, sales engr., and at present asst sales mgr., in charge of industrial coal sales, The Elias Rogers Co. Ltd., Toronto, Ont. (*St. 1928.*)

References: H. E. Bates, C. V. Christie, L. F. Grant, O. T. Macklem, H. J. Lamb.

WORKMAN—WILLIAM ROSS, of Coal Creek, B.C., Born at Kingston, Ont., Dec. 16th, 1907; Educ., B.A.Sc., Univ. of B.C., 1930; 1927-28-29 (summers), recorder and lightkeeper, Geodetic Survey of Canada; 1930-32, grad. student engr., Allis-Chalmers Mfg. Co., Milwaukee, Wis.; 1933-35, washer attendant, Corbin Collieries Ltd., Corbin, B.C. (*St. 1927.*)

References: G. E. Elkington, G. H. McCallum, H. B. Muckleston, E. A. Wheatley, W. H. Powell.

Loeffler System of Steam Production

(*Continued from page 438*)

quickly responsive to variations in load than would be possible by combustion control alone.

The fact that for every pound of feed water supplied to the boiler, about three pounds of steam are circulated, might prompt the fear that so much turbulance in the vaporizer drums would result in a large amount of water being carried out of the drums with the steam. Actually, however, this is not the case.

In comparing the capital costs of complete power stations, taking in one case a low or medium pressure steam station, and the other

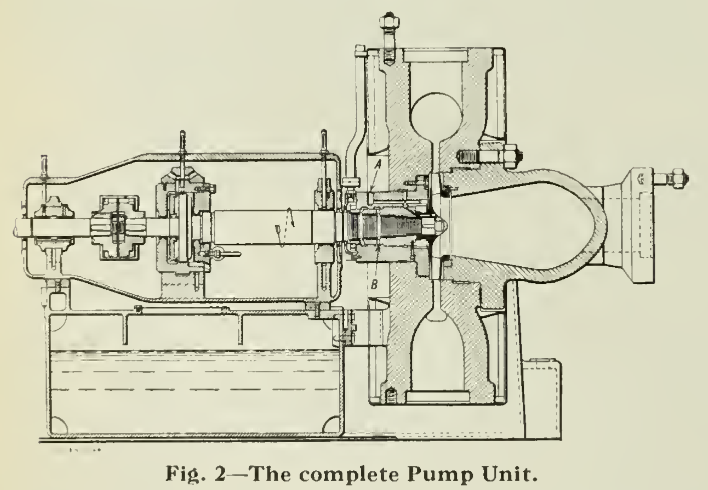


Fig. 2—The complete Pump Unit.

high pressure under Loeffler conditions, so many factors are in favour of the Loeffler system that no additional capital charges need be involved. The reduction in consumption of steam per unit generated, the reduction in fuel to be handled and consumed, the reduced heating surface, the smaller condensers, the lack of necessity for evaporators, the cheaper constructional work owing to reduced space occupied and position of boiler drums, the smaller diameter of steam piping and smaller size of valves, fittings, etc., these items serve to indicate at least that it is reasonably possible to secure the economical advantages of high pressure and high temperature steam without incurring increased capital charges.

The general design and arrangement of the new central power station at Trebovice, Czecho-Slovakia, have been made so that the station in its final form will be able to generate 150,000 kw. The present steam plant consists of three Loeffler boilers each having a capacity at maximum rating of 160,000 pounds of steam per hour at a pressure of 1,900 pounds per square inch, and a temperature of 930 degrees F. The boilers are fired with coal having a calorific value of approximately 12,600 B.t.u. per pound. Two Skoda turbines are installed for an output of 21,000 kw. each. The turbines are bled in three stages for the purpose of heating the feed water to a temperature of 504 degrees F. The steam leaving the first stage of the turbine passes to an intermediate superheater, wherein it is reheated by means of steam from the boiler to a temperature of 645 degrees F.

The following guarantees of performance have been given for this plant:—

Per cent of rated capacity	100	70	40
Kilowatts delivered to consumer	42,000	29,450	17,010
B.t.u. per kilowatt	13,167	12,988	14,553

For the operation of auxiliaries a house turbine has been installed to give a maximum of 3,500 kw. when supplied with steam at 285 pounds pressure per square inch and a temperature of 645 degrees F.

Business Conditions in Canada

Month by month the volume of activity in manufacturing, mining and transportation in Canada shows consistent gain. In each month of 1935 there has been an improvenent as compared with the corresponding month of 1934, and in May the official index of the physical volume of business for the country reached a new high of 103.2. During the first five months of the year the index averaged 98.8 as compared with 91.7 and 69.9 for the corresponding periods of 1934 and 1933 respectively. In terms of volume, the industrial production of the country is half as large again as in 1933.

In view of the prospective improvement in the farmer's purchasing power, a result of generally favourable weather conditions in all parts of the country, there has been less than normal seasonal recession in a number of lines of business this summer. Recently there have been impressive gains in the construction and farm equipment industries.

The agricultural outlook is favourable and without some unforeseen development satisfactory crops should be harvested in many parts of Canada. Damage from rust has seriously reduced prospects for the Western wheat crop. The marketing of a substantial wheat crop would present considerable difficulty, as stocks from last year are still heavy and the carry-over at the end of the present season will show little, if any, reduction from a year ago.

—*Royal Bank of Canada Letter.*

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

ASSISTANT SUPERINTENDENT, for shops, consisting of machine, iron foundry, blacksmith, boiler, and pattern, to employ up to 300 men. Must know latest practices and have been engaged in manufacturing and be able to estimate job costs closely. In reply state education, experience, age, and salary expected. Apply to Box 1190-V.

Civil Service Vacancy

JUNIOR STRUCTURAL ENGINEER

2426I.—A junior structural engineer in the Penitentiaries Branch of the Department of Justice at Ottawa at a salary rate of $1,800 per annum.

Duties.—Under direction to assist in the design, inspection or supervision of construction of buildings and other structures of steel, concrete and wood; on occasion to make estimates of cost and to prepare specifications and bills of material and to perform other related work as required.

Qualifications required.—Education equivalent to High School graduation with four years of experience in Structural Engineering, design, inspection and construction; or graduation in engineering from a school of applied science of recognized standing, with two years of experience in structural engineering, design, inspection or supervision of construction; corporate membership in The Engineering Institute of Canada, or membership in a Provincial Association of Professional Engineers, or professional qualifications which would permit of such membership.

While no age limit has been set for this competition, age may be a determining factor.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, **not later than September 19, 1935.** Application forms may be obtained from the offices of the Employment Service of Canada, from the Postmasters at any City Post Office, The Engineering Institute of Canada, or the Secretary of the Civil Service Commission, Ottawa.

Candidates must be British subjects, and have resided in Canada for at least five years.

Situations Wanted

ESTABLISHED SALES ENGINEER, Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

SALES ENGINEER, S.E.I.C.; B.SC. C.E., 1930 (Univ. New Bruns.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

Situations Wanted

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experiences on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

Employment for Engineers Improved

During the past four months employment for engineers has showed a marked improvement. This has been particularly noticeable in Quebec, Ontario and the middle west.

In Quebec and Ontario very few members are now actually unemployed except in a small number of cases where those with specialized experience have not found a demand for their services.

It is hoped that the improvement already so marked will continue as this should afford an opportunity to place a number of those engineers in other localities or who are in unsuitable positions.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

Situations Wanted

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experiences includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, B.SC. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.SC. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.SC., '25, JR.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

Situations Wanted

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

Situations Wanted

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

COMBUSTION ENGINEER, A.M.E.I.C., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '29). Age 28. Six years experience in automobile office and plant; two years as supervisor of inspection in body assembly. Good understanding of modern business methods applied to manufacturing. Desires position with production department of smaller Ontario industry. Good references. Interviews anywhere in central Ontario. Apply to Box No. 1270-W.

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Volume XVIII — Montreal, October, 1935 — Number 10

Some Basic Principles in Making Durable Concrete

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Paper presented before the Ottawa Branch of The Engineering Institute of Canada on March 21st, 1935, and before the Montreal Branch on March 28th, 1935.

SUMMARY.—The chemical changes which accompany the setting of Portland cement and the relation between water-cement ratio and the quality of concrete are discussed. The paper then considers in some detail the precautions necessary in mixing, placing and curing concrete, if durability and water tightness are to be obtained.

Ordinary concrete is composed of three ingredients: cement, water and aggregates. The simplicity of the materials used tends to make it appear to the average man that it is an easy article to manufacture. No doubt this false view is responsible for much of the inferior and unsightly concrete that one sees. However, these failures of the past have led to much research which has resulted in a fairly well defined science of the art of making economically durable concrete.

A thorough understanding of the science of making durable concrete involves the knowledge of the compounds entering into the composition of Portland cement, their reaction with water, and the function of the aggregates used in the water-cement paste.

The following are the principal components of ordinary Portland cement and their approximate percentages based on several analyses made on cements from five Canadian mills: Tricalcium silicate, 50 per cent; beta dicalcium silicate, 25 per cent; tricalcium aluminate, 11 per cent; tetracalcium alumino ferrite, 8 per cent; in all a total of 94 per cent.

Hydration of Portland Cement

These compounds of Portland cement react with water to form the hard matrix which binds the aggregates into a solid mass. A knowledge of the rate at which water reacts with these compounds is important in the production of durable concrete.

Tricalcium aluminate is the first compound to react chemically with water and imparts most of the early strength of concrete. Its reaction is practically complete in the first twenty-eight days under favourable conditions.

Tricalcium silicate is the next ingredient to contribute to the early development of strength. Tricalcium aluminate and tricalcium silicate are responsible for most of the twenty-eight day strength, although tricalcium silicate continues to impart strength at a diminishing rate after the twenty-eight day period.

Beta dicalcium silicate contributes little to the strength up to twenty-eight days, but is largely responsible for the increase beyond that period.

Tetracalcium alumino ferrite is not an important ingredient and its role is not so well defined. It is known, however, to influence the strength after one day up to a period beyond twenty-eight days.

The significance of the hydration of these compounds will be discussed further under "curing."

Concrete may be thought of as a mixture of inert aggregates held together in a hardened water-cement paste. As will be shown later, the characteristics of the aggregates have an important influence on the properties of the concrete, but concrete derives its main characteristics from the water-cement paste. Then, for the moment, consider the properties of the paste apart from the aggregates.

The water-cement ratio may be defined as the ratio of the quantity of water to the quantity of cement expressed in suitable units. The units most commonly used are: volume, weight, and gallons of water per sack of cement. The latter is, perhaps, the most practical for every day use and can be readily converted to the other units when desired.

The water-cement ratio has been found to serve as an index by which the quality and properties of the paste may be expressed. In fact, a thorough understanding of the considerations involved implies a fairly thorough knowledge of the use of cement.

Compressive Strength of Concrete

Duff Abrams about 1918 discovered that a definite relationship exists between the water-cement ratio employed in concrete and its compressive strength providing that the concrete is plastic and capable of being placed without segregation. That is, the concrete must not be so dry and stiff that it cannot be placed, nor so wet that when placed the ingredients will segregate. Abrams found the relationship between the water-cement ratio and strength to be as given in Table I.

Table I

Compressive strength, Pounds per square inch at 28 days	Water-cement ratio, Imperial gallons per Canadian sack of cement (87½ pounds)	
1000	7.83	
1500	6.63	
2000	5.78	(these results are for average materials cured at a temperature of 70 degrees F. under moist conditions.)
2500	5.11	
3000	4.57	
3500	4.11	
4000	3.72	
4500	3.37	
5000	3.06	

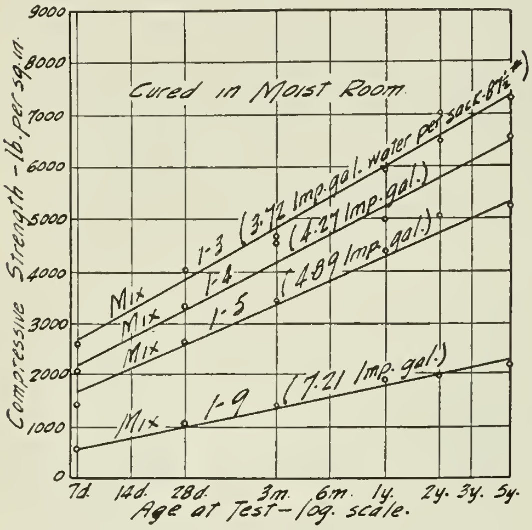

Fig. 1.

Immediately the water and cement are mixed together a chemical reaction commences in which a portion of the mixing water combines with the various compounds in the cement to form hydrates, causing the paste to harden and impart strength to the concrete. This being a chemical reaction the rate at which it proceeds is dependent upon the

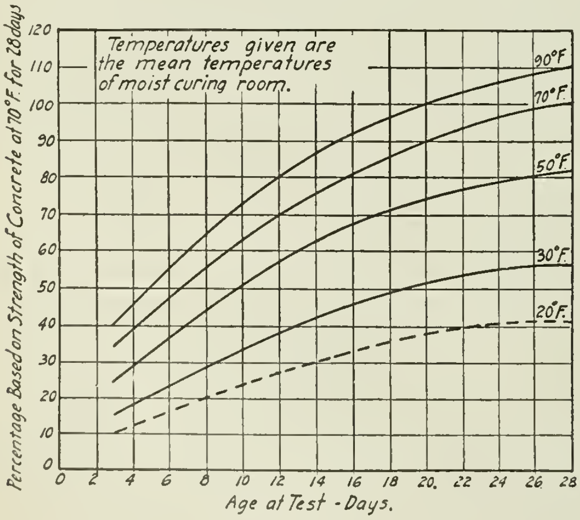

Fig. 2.

temperature and the amount of water available. Therefore, it becomes worth our while to investigate the increase in strength of the paste as related to the temperature and conditions of moisture during the curing period.

The strength of the paste, or concrete containing it, increases rapidly at first and continues to increase indefinitely but at a slower rate. (See Fig. 1.)

The higher the temperature within limits the greater the rate at which the strength increases. (See Figs. 2 and 3.)

Water must be available or hydration cannot take place. If concrete is left exposed to a dry atmosphere, as found in an ordinary room or out-of-doors in summer weather, it will become dry and the gain in strength will be retarded or even stopped. It is interesting in this connection to note that all of the water supplied in mixing concrete is not used in the hydration of the cement. Considerably more than half of the water is only added for the purpose of lubricating the mixture sufficiently so that it can be placed with ease in the forms. This excess of water will eventually evaporate from the concrete which is not in contact with water but it must not be allowed to do so before sufficient hydration has taken place to permit the required strength to be attained. The combination of the water with the cement is one which evolves heat and this heat besides having other effects has a tendency to drive off the water from the mix and hasten its drying. (See Fig. 4.)

Permeability

The rate at which water passes through a piece of concrete will depend upon the water pressure, the thickness of the concrete, and its ability to resist the passage of water. Tests show, for given conditions, that the rate of flow depends upon the water-cement ratio and also that

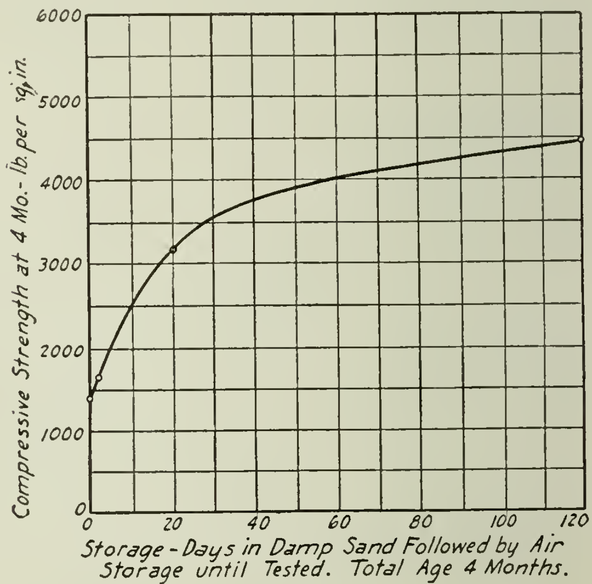

Fig. 3.

concrete can be made watertight. If the water-cement ratio does not exceed four and one-half gallons of water per sack of cement it may be safely said that the concrete will be watertight under all ordinary conditions. This implies that the concrete be uniform throughout and does not mean that it will not leak if the ingredients of the concrete are allowed to segregate and the water-cement ratio allowed to increase in portions of the mass. It does mean, however, that with moderate care watertight concrete may be obtained. (See Fig. 5.)

Volume Changes

With variations in temperature or conditions of moisture, the volume of concrete changes. The thermal coefficient of expansion of the average concrete is for all practical purposes the same as that of the average steel. Usually in the design of concrete structures provision is made for expansion and contraction by the use of expansion joints. Changes in volume in concrete due to changes in moisture are approximately equal in magnitude to the thermal variations but are different due to the fact that they are almost entirely produced within the cement paste. Hence, volume changes in concrete due to this cause are roughly proportional to the richness of the concrete mixture.

One of the advantages claimed for vibration, which will be discussed later, is that the volume changes due to variation in moisture will be greatly reduced. This is because it makes possible the placing of concrete with

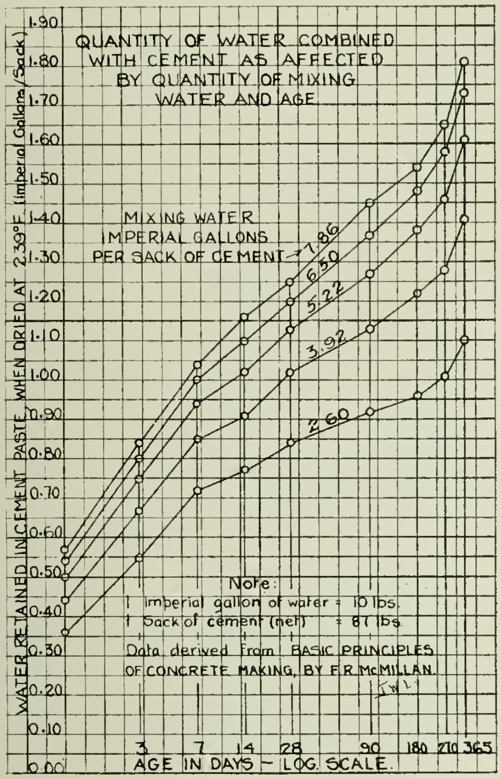

Fig. 4.

smaller amounts of water and hence smaller amounts of cement for a given yardage of concrete.

Aggregates

Aggregates used in concrete may be briefly classified as follows: sand, gravel, crushed stone, slags, cinders, clay and shale products, iron ore and steel mill scrap.

Sand, gravel and crushed stone, are the most commonly used. It is probable that the use of stone-sand (that is, fine crushed stone) will in the future replace a considerable quantity of the natural sand used at present. This will take place with the depletion of the natural supplies, with improvements in machinery and technique, organization, and with an increasing demand on the part of users for a product of better quality.

The use of cinders is quite common in certain types of construction. Aggregates specially manufactured from clay and shale have come to the fore in recent years and although they are in themselves expensive their use makes possible savings in weight which in certain types of structures may warrant their use.

The heavy materials are not commonly used except in special cases where great weight is necessary, such as in counterweights for bascule bridges.

The selection of the aggregates for any particular work requires a knowledge of the type, details and exposure of the structure, along with a knowledge of the properties of the various types of aggregates. In considering the properties of aggregates it may be helpful to do so under the following headings:

(*A*) Structural strength of aggregate particles,
(*B*) Durability of the aggregate,
(*C*) Content of deleterious and extraneous materials,
(*D*) Grading, percentage of voids, maximum size and shape of the particles.

(*A*) *Structural Strength of Aggregate Particles*

The compressive strength of stone varies up to about 25,000 pounds per square inch. When an aggregate of fair strength is used the designed strength based on the water-cement ratio may be expected to control the strength of the concrete. A weak aggregate would, on the other hand, be expected to reduce the strength. The aggregates of very low strength are not difficult to detect in that they are easily broken in handling or with a light blow from a hammer.

(*B*) *Durability of the Aggregate*

At one time all failures of concrete were blamed on the quality of the cement. Since then much has been learned about both cement and aggregates and it is now agreed that most failures are due to the use of poor aggregates, high water-cement ratios, and poor or careless methods of manufacturing, transporting, placing and curing of the concrete. The question of the durability of the aggregate then becomes a real one when considered in the light of present day knowledge and the problem now resolves itself into a study of methods for detecting the aggregates of poor quality.

In general the weaker aggregates are the less durable. It is also true that the more durable aggregates are generally from the stronger rock formations, but it does not necessarily follow that all strong rocks make durable aggregates.

The following procedure is useful in investigating the durability of an aggregate:

(*a*) Mineralogical classification,
(*b*) Inspection of quarry or pit,
(*c*) Inspection of structures containing the aggregates in question,
(*d*) Laboratory tests.

(*a*) From a mineralogical classification it may be possible to determine whether or not the material falls into a class which can be expected to be durable.

(*b*) By inspecting a quarry or gravel pit which has been in use for a number of years one can determine the

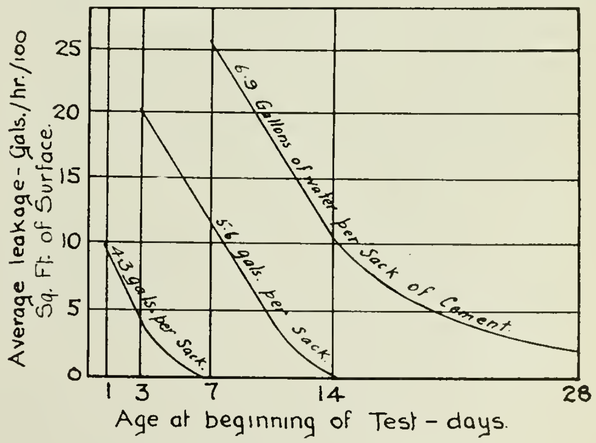

Fig. 5—Permeability of Concrete.

ability of the materials to resist weathering from the open faces and the waste therein.

(*c*) By inspecting structures of a similar type to the one for which the aggregate is being sought and containing the aggregate in question one may determine its durability.

(*d*) Frequently new quarries are opened and there is no opportunity to determine the quality of the aggregates by their past records and in such cases accelerated laboratory tests are particularly useful. These tests usually consist of freezing and thawing or of performing what are known as artificial freezing and thawing tests. These latter consist of alternately immersing the aggregates in a solution of sodium or magnesium sulphate and drying them in an oven. In both cases the number of cycles required to cause the aggregate particles to disrupt is considered to be a measure of the durability of the aggregate.

Fig. 6—Failure due to Inferior Aggregate.

There is some difficulty in determining what weight should be attached to the results of these tests and at best they can only be considered as a guide in the selection of suitable aggregates. However, there is an attempt being made to standardize both the artificial and actual freezing and thawing tests.

(*C*) *Content of Deleterious and Extraneous Materials*

Aggregates should not contain alkalis nor organic matter in sufficient quantity to be harmful. Actual tests of the aggregates with cement in mortar or concrete are perhaps the best way of determining the effect of such materials when present. The percentage of soft, laminated, elongated and thin flaky particles should be kept at a minimum as their presence cannot be beneficial. Frequently an aggregate taken from a river or lake may contain sufficient quantities of wood and bark to cause failure of the concrete in which it is used if it is exposed to the actions of water and frost.

In many cases aggregates are washed in order to remove undesirable materials, but here a word of caution is in order. In a fine aggregate a small percentage of very fine material is desirable, therefore, too much of it should not be removed by washing in order to retain the workability of the concrete.

The form in which a material is present is also important. Clay in the form of lumps can be harmful in that it will contribute to the disintegration of the concrete, while on the other hand, it has been found that small percentages of clay when in the finely divided state, well diffused and free from organic matter, is not detrimental and may be beneficial when fines are lacking.

(*D*) *Grading, Voids, Shape of Particles, Maximum Size*

The grading of aggregates is important but also complicated. There has been much written on this subject and perhaps the only conclusion one can draw is that there is no particular grading which can be considered ideal. On the other hand there are a few points to be watched.

The uniform grading, or that represented by a smooth curve, is generally accepted as being the most satisfactory. Recently some have advocated and used gap grading, that is, a distribution in which a certain size is absent. Gaps are no doubt preferable to humps or excessive quantities of material of one size. Where humps occur on the curve particle interference is indicated. This means that there are too many particles of one size which increase the voids and decrease the workability of the aggregate.

It is a known fact that the finer a material the easier it is to work it. For instance, it is easier to shovel sand than to shovel gravel or crushed stone. Hence, if the grading is such that the particles, when moved, roll around on smaller particles, the workability of the grading should be at a maximum.

When the weight per unit volume and the specific gravity of the aggregate are known it is possible to compute the volume of its voids. The percentage of voids serves as a measure of the quality of the grading and further it can be shown that the quantity of cement required for a unit volume of concrete of a given water-cement ratio is directly proportional to the percentage of voids in the aggregate. (See Figs. 8 and 9.)

The shape of the particles has a bearing on the workability of the aggregate. Flat or elongated particles will increase the voids and decrease the workability. Gravels which are smoothed and rounded produce more workable mixtures than do irregularly shaped pieces of crushed stone. In crushing stone it sometimes happens that a large percentage of flat or elongated pieces are formed. A stone may have a natural tendency to break in this manner, but it can to some extent be remedied by the use of crushers designed to break the pieces into cubical shapes.

The maximum size of the particles has an influence on the cost of the mix, the cost of placing and on the structural properties of the concrete. For economy in mix design the maximum size should be as large as possible. By following this rule the surface area of a unit volume of aggregate will be decreased and the result is an appreciable economy in the amount of cement required for a given water-cement ratio. On the other hand the maximum size should not be greater than that which can be easily handled in mixing, nor should it be greater than that which will easily go through the reinforcing. Further, from a structural point of view, the aggregate should not exceed one-quarter of the least dimension of the member in which it is to be used.

Fig. 7—Fragments of Wood and Bark in Concrete.

Influence of Aggregates on the Compressive Strength of Concrete

The water-cement ratio of a concrete mixture controls its strength but each type of aggregate has also some influence. A structurally weak aggregate, one containing organic impurities, or one with surfaces so smooth that the water-cement paste will not bond to it, can be expected to lower the strength. On the other hand, certain types of aggregates yield strengths above that expected of a given water-cement ratio, and that may possibly be attributed to surface texture. The influence of the aggregate should be determined since it will have an influence on the cost and quality of the concrete produced.

In designing a concrete mixture the following information should be available and from it the necessary decisions made. (See Table II.)

Table II

Information Required and Factors to be Determined when Designing Concrete Mixtures

Information Required	Factors to be Determined
Necessary structural strength of concrete. Conditions of exposure of concrete. Properties of available aggregates.	Water-cement ratio.
Type of structure. Size of members. Quantity of reinforcing. Method to be used in placing concrete.	Maximum permissible size of aggregates. Workability and consistency of the concrete.

Table III will serve as a guide in selecting the correct water-cement ratio for various conditions of exposure.

Table III

A Guide in Selecting the Correct Water-cement Ratio for Concrete Under Various Conditions of Exposure

Class of Structure / Exposure	Water-cement ratio Imperial gallons water per Canadian sack of cement [1]		
	Reinforced piles, thin walls, light structural members	Reinforced reservoirs, water tanks, pressure pipes, sewers, canal linings, Dams of thin sections	Heavy walls, piers, foundations, Dams of heavy sections
Extreme: In severe climates as in Canada, exposure to alternate wetting and drying, freezing and thawing, as at the water line in hydraulic structures. Exposure to sea water and strong sulphate waters.	4½ (3000)	4¼ (3300)	4½ (3000) [2]
Severe: In severe climates as in Canada, exposure to rain and snow and freezing and thawing but not continuously in contact with water.	4½ (3000)	4½ (3000)	5 (2500)
Moderate: Concrete completely submerged and protected from freezing.	5 (2500)	4½ (3000)	5¾ (2000)
Protected: Ordinary inclosed structural members; concrete below ground not subject to action of corrosive ground waters or freezing and thawing.	5¾ (2000)	4½ (3000)	6¼ (1500)

(1) Free water or moisture carried by the aggregate must be included as part of the mixing water.

(2) Figures in brackets indicate the approximate compressive strength of the concrete.

The above table is predicated on the use of materials and methods meeting the requirements of standard specifications and recognized good practice.

When the aggregates have been selected and the water-cement ratio decided on, the actual design of the mix becomes a matter of determining the relative quantities of fine and coarse aggregate and the amount of water-cement paste required per unit volume of concrete, usually a cubic yard.

The object of designing a mix is to secure for the least cost a concrete which will possess adequate workability or placeability, strength, watertightness, durability, etc., from the materials available. The much too common practice of specifying that a concrete mix shall consist of one part of cement to so many parts of fine and coarse aggregate by volume without any knowledge of the characteristics of the aggregates is to be condemned as unscientific and inadequate if either economical or durable concrete is to be secured.

There are methods of computing approximately the quantities of materials required in a concrete mix, notably that developed by Abrams, but these methods require a knowledge of the characteristics of the materials and even then do not account for all the variables and result only in an approximate solution. In fact, the Abrams' method does not claim to do more and the actual mixing of trial batches are considered a necessity.

The procedure in designing trial batches is to assume the quantities of fine and coarse aggregate, cement and

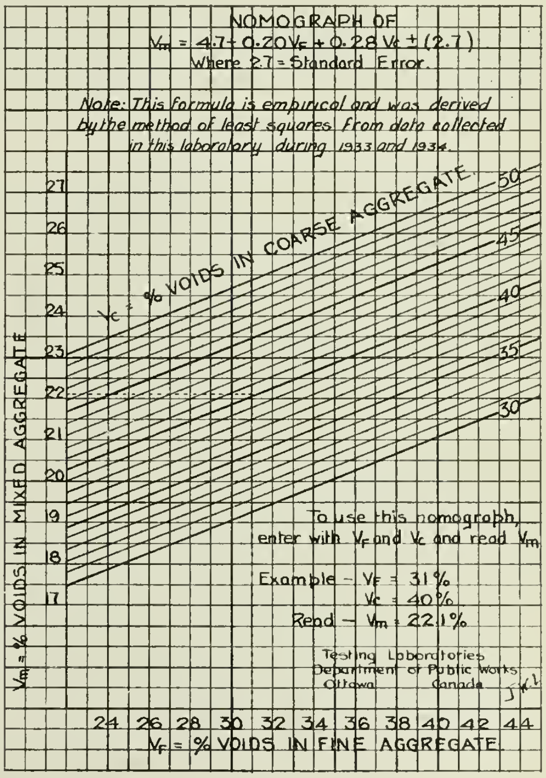

Fig. 8.

water for a trial batch of a convenient volume of concrete, to mix these together and examine the mixture for workability, water-cement ratio and other desired properties. Each individual who happens to be doing this work will develop his own technique and methods of arriving at a satisfactory mix with as few trial batches as possible. One convenient method is to assume slightly less fine aggregate than is likely to be required and to add more when and if it is seen to be necessary for workability and to add the water to the mix a little at a time until the desired consistency is obtained. When a mix of suitable workability is secured the relative amounts of each ingredient may be computed, the volume of the concrete so produced measured or computed from the absolute volumes of the materials and the water-cement ratio determined. With a little practice it will be possible to design a mix of suitable workability with usually one, and not more than two, trial batches. It has been found that for a given aggregate

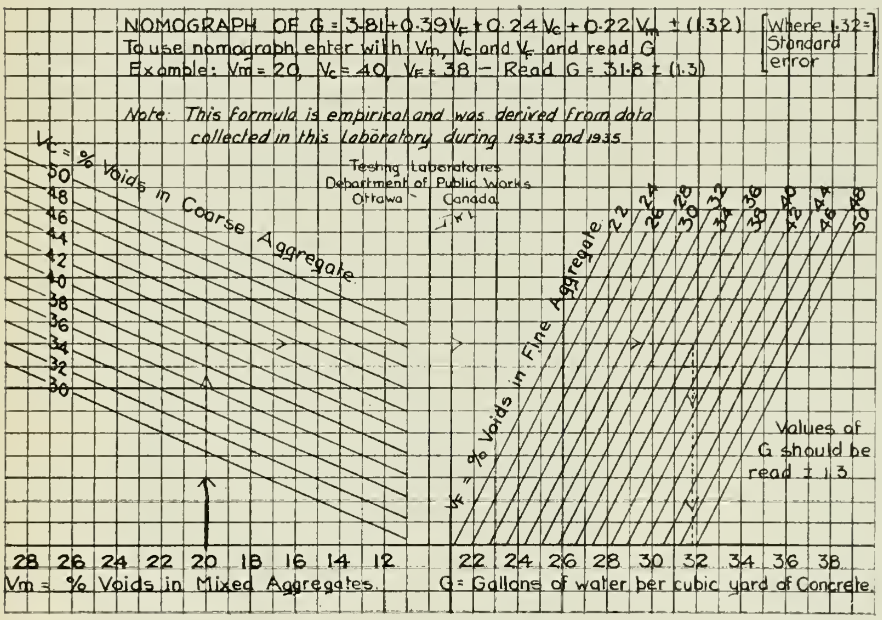

Fig. 9.

combination, and for a given consistency, the quantity of water required per unit volume of concrete will be constant regardless of the water-cement ratio. Hence, knowing the quantity of water required per unit volume of concrete it only becomes necessary to divide the total number of gallons of water in a unit volume of the concrete, by the water-cement ratio in gallons per sack, and to increase or decrease the amount of aggregate, an amount equal to that required to maintain a constant volume of concrete. (See Fig. 10.)

In the case of concrete ranging in strength around 3,000 pounds per square inch, a variation in the water-cement ratio of one-half gallon of water per sack of cement corresponds to a change in strength of approximately 500 pounds per square inch. The reason for stating above that this conversion method should not be used without further trial batches, if the change were greater than the amount indicated, is because when large changes in the cement content of the mix are made a change in the grading of the aggregate may also be desirable. Cement, besides forming the water-cement paste, serves as fine material and increases the workability of the mixture. Hence, the richer the mix, the more workable it should be, and it is often possible to alter the aggregate grading by reducing the sand content and thus securing a more balanced design.

Concreting Operations in the Field

There are many elements which enter into proportioning, mixing, and placing of concrete in the field which are sometimes difficult to control but if economical and durable concrete is to be secured the mixer must produce uniform batches, and the concrete must be conveyed to and placed in the forms without segregation.

Aggregates should be delivered to the job separated into several sizes. In no case should a pit-run material be used without first separating the fine from the coarse by screening and then use them from their separate piles in a definitely established ratio; firstly, because it will be found impossible to secure uniformly graded material from a pit-run aggregate and secondly, the various sizes will separate in transportation and storage. For the same reason it is bad practice to buy ready-mixed aggregate. As a general rule the fine aggregate will pass the ⅜ or ¼-inch screen and in such cases no trouble will be experienced from segregation of the various sizes, also, the fine aggregate usually contains sufficient moisture to prevent any tendency of this nature. Coarse aggregate varies in size from about ¼ of an inch upwards, the maximum size depending upon the nature of the work. When the maximum size is large, much segregation will occur in either stock piles or bins. The lack of uniformity of grading of the coarse aggregate produced in this way is sufficient in many cases to cause wide variations in the consistency of the mix. The obvious solution is to separate this material into two or more sizes and to recombine them as stated above. In cases where the range in size is not too large and conditions permit considerable improvement can be secured by storing the material in low stock piles where the effect of segregation will be minimized. The aggregate should be delivered on a hard clean base from which shovelling is easily performed and should always be shovelled from the bottom of the pile so as to remix it, thus securing uniformity.

The next step in the production of uniform concrete lies in the measuring of the various materials. It has been customary in the past to proportion by volume, but recently the practice of weighing has come into more common use with good results. Weighing has the advantage of being fundamentally a more accurate method of measuring aggregates, and further, the effect of moisture in the aggregates is more easily controlled. Moisture in the coarse aggregate has little effect other than to add to the mixing water, but moisture in the fine aggregates besides adding to the mixing water causes bulking of the sand. This bulking amounts to an increase in volume ranging up to about 40 per cent, depending upon the amount of moisture present and the grading of the fine aggregate. Bulking, of course, is only an apparent increase in quantity and when not compensated for by increasing the amount of fine as measured by the volume method, results in a deficiency of fine which decreases the yield and workability of the concrete. With the moisture content changing from day to day, or even from hour to hour, it is not easy to measure the desired quantities of fine aggregate accurately by the volume method.

The mixer should be of adequate capacity and design to handle the materials being used and to produce sufficient concrete for continuous placing. The rate at which the mixer turns should be sufficient to mix thoroughly, but should not be so great that the centrifugal force will cause the particles of aggregates and cement to be thrown to and remain on the drum of the mixer. The time of mixing should be sufficient to cause a complete mixture of the ingredients and should never be less than one and one-half minutes. The mixer should discharge a homogeneous batch of concrete and not one in which the mortar is first delivered and finally the coarse aggregate.

Two factors enter into transportation of the mixed concrete: time and segregation. The element of time between mixing and placing is usually given adequate recognition and is only a problem in special cases. Recent tests indicate that provided the concrete is placed in the forms within two hours of the time it is first mixed, and provided that no addition of water is added, the strength remains unchanged. Too frequently the methods of conveying the concrete from the mixer to the forms permit considerable segregation. This is to be carefully avoided if durable concrete is to be obtained and the concrete should arrive at the forms in as uniform a state as when it left the mixer. Any method which accomplishes this may be considered satisfactory.

Methods of Placing

Poor methods of placing concrete have been found to account for a greater number of failures than any other single cause. A few simple rules, if observed, should result in a concrete of a homogeneous and durable character.

(*a*) The concrete should be placed where it is to remain and should not be deposited in one spot and allowed to flow to other parts of the form. If permitted to flow, the water and finer materials will find their way to the sides and corners of the forms, resulting in a material of high water-cement ratio and low strength in the parts most vulnerable to attack.

(*b*) Lift planes should be avoided wherever possible. It has been common practice in the past when filling a form to cease operations at intervals to allow the relief of pressure on the forms, or for the construction of additional form work. Considerable difficulty has been experienced in bonding a lift of concrete to the one previously placed and the result is seen in nearly all dams, piers and retaining walls, in the form of horizontal joints or lift planes. A superior practice is to complete the filling of any form in one continuous operation and thus avoid the danger of poor joints. (See Fig. 11.) Figure 12 shows piers 25 feet high placed in one continuous operation making a true monolith.

(*c*) Concrete should be placed in layers not exceeding one foot in thickness. Each successive layer should cover the entire area of the form and should be well worked into the previous layer. Not more than one-half to three-quarters of an hour should elapse between layers. These requirements demand good forms and a mixer of sufficient capacity to supply the concrete at the necessary rate.

(*d*) Water gain should be avoided or taken care of. When concrete is deposited in the forms and allowed to remain undisturbed, as should be done in placing, there is a tendency for the water to rise toward the top of the mass. In its upward travel the water is impeded by the aggregate and reinforcing steel. The result is an increase in the water content of the mortar immediately under the coarse aggregate particles and at or near the top of the mass. Water gain has been found to be a manifestation of the tendency of a cement to "bleed" or to give up the water mixed with it. The "bleeding" tendency of the cement has been found to be reduced as the fineness of the cement is increased and water gain in the mix is reduced as the design of the mix is improved and is less for the dryer than for the wetter consistencies. Frequently water is found to collect on the top of the concrete in the form while placing and this accumulated water can be absorbed by a few batches of dryer concrete provided that the quantity is not too great. Where the quantity of water is too great it is advisable to remove it from the forms.

Vibration

In the past, concrete has been almost entirely placed with the aid of hand tools, but more recently mechanical vibrators have come into prominent use.

Vibration is a new development and undoubtedly is a decided advancement in the art of making concrete, but because it is new our knowledge of its effect is not complete. At present, at least, it should be considered only an aid to the placing and compacting of the concrete in the forms. This will permit the successful placing of dryer and harsher

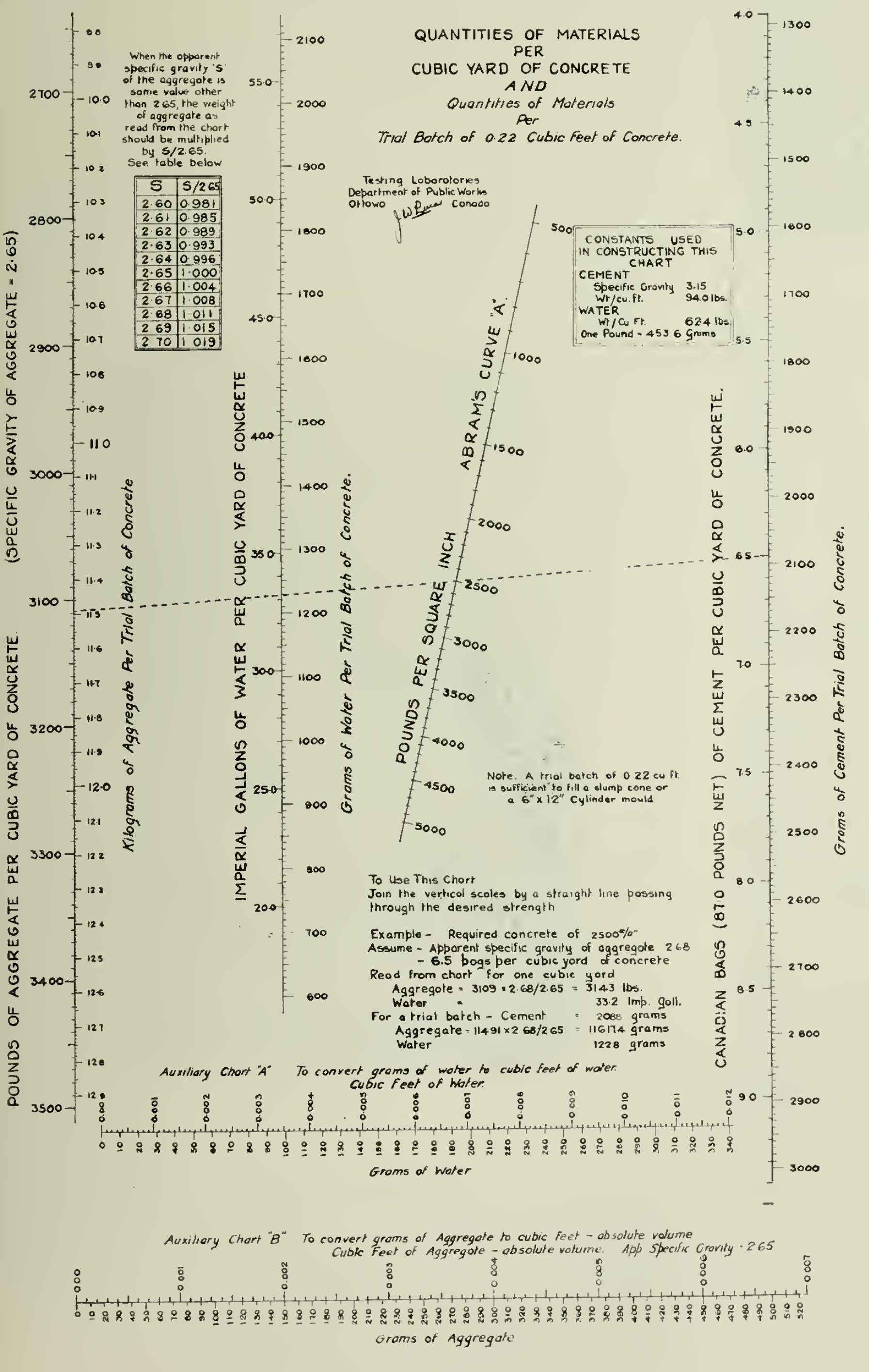

Fig. 10.

mixes than by hand methods. This makes possible either a saving in cement, if a constant water-cement ratio is maintained, or an increase in the strength of the concrete if the cement content is unchanged. Existing data would indicate that a saving in man power in placing the concrete is also possible. Against the saving in cement and labour must be balanced the cost of vibrating but it is generally conceded that an over all saving in cost is secured. In addition to the immediate saving in cost of the concrete

Fig. 11.

the effect of lower cement and water content, increased density, and a lesser tendency towards segregation and water gain, cannot be overlooked in the quality of the concrete produced. It was mentioned above that the design of the mix may be changed to effect a saving and in this connection it has been established that it is necessary to reduce the water and fine aggregate content in the mix to secure satisfactory results. This is so because the effect of vibration reduces the internal friction of the mixed particles to such an extent that if mixes of ordinary workability and consistency are used segregation will result. The amount of vibration required will depend upon the mix and the nature of the work, and care should be taken that it is not overdone to the extent of causing segregation.

Bonding New to Old Concrete

It has been stated that horizontal joints or lift planes should be avoided wherever possible. At times this is impossible and at other times it becomes necessary to bond new to old concrete. Where it is impossible to avoid lift planes the top surface of the concrete should be approximately a smooth surface. It need not, of course, be a plane surface, nor need it be carefully finished, but it should be smooth enough to permit easy and thorough cleaning and an effective glueing of the next lift of concrete to the hardened surface. When water gain takes place in a setting concrete mass the rising water carries to the surface very fine particles of aggregate and hydrated cement, depositing them there as a layer of laitance. This substance has a chalky appearance, having no appreciable strength, and of a porous character. Immediately below the laitance layer the concrete may be weakened and made porous through water gain.

In general, the securing of watertight joints, when bonding new to old concrete, is difficult, but if bonding must be resorted to the following methods may be used with fair success:

First Method:

(*a*) Thoroughly clean and dampen the surface of the concrete.
(*b*) Sprinkle neat cement on the dampened surface to a depth of about 1/16 inch.
(*c*) As soon as the cement becomes wet through from the moisture below, cover it with about one inch of mortar made with one part cement to two parts sand.
(*d*) Proceed on top of this with the regular concrete.

The cement film on the surface of the concrete acts as a cushion to receive the grains of sand of the mortar and the mortar acts as a thicker cushion to receive the coarse aggregate of the regular mix.

Second Method:

This method consists simply of cleaning and dampening the surface of the concrete and covering it with a rich cement grout, generally a 1 to 2 mix, to a depth of about one inch in which the regular concrete is placed.

These precautions are necessary if watertight joints are to be secured and from experience too much care cannot be taken. It will now become obvious that bonding new to old concrete in a satisfactory manner is not an easy matter, is costly, and wherever possible should be avoided by adopting such methods as will permit continuous placing.

Curing

It was pointed out earlier that time and definite conditions of temperature and moisture are necessary for the concrete to develop its required properties. The conditions required are the same in all cases but the method of attaining them may be different on different works.

Fig. 12.

Curing means the hydration of the compounds of the cement. Their hydration is a slow chemical reaction even under favourable conditions. For example, the result of many tests show that concrete under moist conditions at 70 degrees F. acquires during its first seven days about two-thirds of its twenty-eight day strength, and during its first twenty-eight days about 50 per cent of its five-year strength. The percentage of the different components of Portland cement and the time they take to react with water, as mentioned under "Components" and "Hydration of Portland Cement," will be found to be in harmony with these average strengths at these ages. Hence the importance that the average concrete be protected against low temperatures and kept damp for a period of at least ten to fifteen days. However, the service to which the concrete is to be subjected, the size of the members, the thickness of the slabs and the season of the year in which it is laid have to be taken into consideration. The smaller

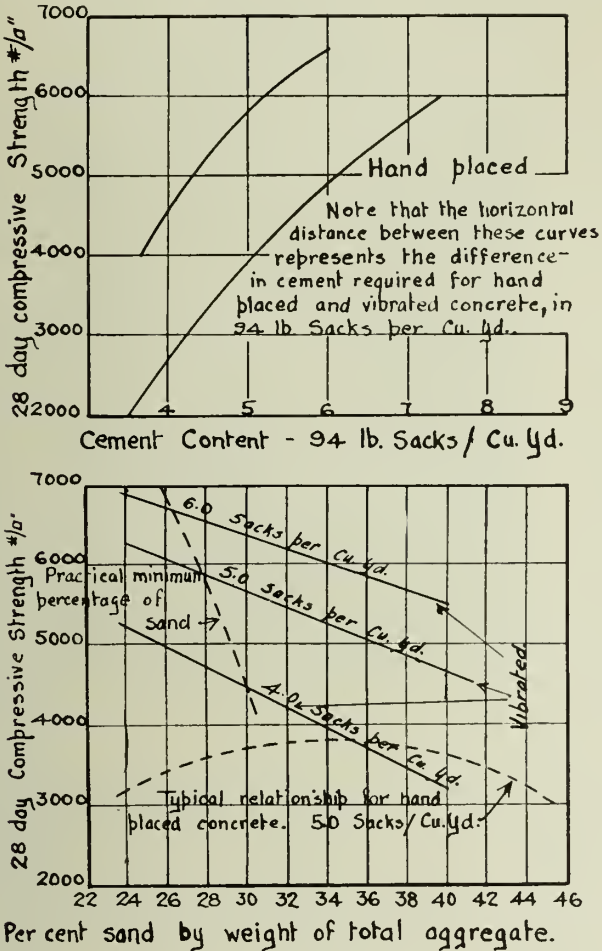

Fig. 13—Vibration Studies.*

the member or the thinner the slab the more protection it should be given.

*Curves taken from a paper entitled "Vibrated Concrete," by T. C. Powers, published in Vol. 29 of the Journal of The American Concrete Institute.

Concrete that is allowed to dry too soon after being laid, especially small members and thin slabs, such as road and floor slabs, will contract due to loss of moisture and will be subjected to stresses that are often greater than the strength developed, thus causing cracks. These cracks may not be visible to the naked eye for days or even weeks, nevertheless, they were developed in that early tender period.

In recent years more and more concreting operations have taken place during the late fall and winter months and there is no objection to that as long as the proper precautions are taken. For instance, no one would think of growing flowers and vegetables in the winter months in this country without doing so under artificial conditions. The growth of these is due to chemical reactions which do not take place unless the conditions are propitious. It is the same with concrete. What the concretor has to do is to learn that he must carry on his winter operations under artificial conditions.

In conclusion it may not be amiss to say that our knowledge of the proper use of cement has not spread as fast as its use. The methods in vogue thirty-five years ago are still in use today and this is true even on works of considerable proportions.

Our city building codes might well afford greater protection to builders and owners by demanding of concretors some proof of their ability and willingness to manufacture and properly place concrete of good quality. By such means the efficient and conscientious contractors would be benefited and the public would be protected against inefficiency and the unscrupulous.

The significance of studies of methods whereby more durable and serviceable concrete may be produced is revealed when one looks into the immense increase in the use of cement in a comparatively short period. In 1900 this country consumed less than 500,000 barrels. In 1920, nearly 6,000,000; in 1925, over 7,000,000; and in 1929, over 12,000,000 barrels of cement were used. Since then the consumption has materially decreased but this can, no doubt, be considered temporary.

12,000,000 barrels of cement represent in round figures 10,000,000 cubic yards of concrete and at an average cost of $10.00 per cubic yard, this would amount to $100,000,000. The annual expenditure of this sum of money indicates the magnitude of the concrete industry in Canada and in the opinion of the authors justifies the expenditure of considerable effort in securing concrete of better quality than much of that produced today. The added inconvenience and cost of repairing or replacing leaking walls, dams, dusting floors, crumbling and unsightly structures of many kinds certainly warrants the study of known methods of producing serviceable and durable concrete.

Electric Heating

As Applied to Hydraulic Control Gates, Buildings and Industrial Processes

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, April 11th, 1935.

SUMMARY.—The author discusses methods of employing electric heating for the prevention of ice troubles in hydraulic regulating gates and the equipment desirable for this purpose. Notes follow on the use of electrical energy for heating power houses, substations and buildings generally. The paper also deals with some problems connected with industrial heating processes.

Heat is produced in an electric circuit by introducing some conductor which resists the flow of current. This resistor may be a metallic wire or ribbon supported on suitable insulators or embedded in a compacted refractory material. It may be some form of non-metallic conductor, rod, plate, or filament. Some liquids may be used as heat producing resistors, a familiar example being the electrode boiler. Heat may also be produced by induction at high frequency.

In Canada great resources in water power help to offset a lack of certain fuels. An abundant supply of low cost electric power has made possible several developments in electric heating which conditions in the United States have not encouraged. There, the higher cost for electric power and the competition of highly developed automatic fuel heating, have forced an intensive study of ways to apply and control electric heat. Like all new developments, it has suffered somewhat from overzealous promotion and inexperienced planning. However, progress is being made and electrically produced heat is beginning to receive the consideration it deserves.

Electric Heating as a Means of Ice Prevention

The entire field of electric heating is so large that only a few of its phases can be discussed here. One subject of special interest is ice prevention, particularly in relation to hydroelectric projects. In many parts of Canada winter conditions are particularly severe but also in much of the northern portion of the United States there is trouble with ice. This trouble is not entirely proportional to the severity of the climate but depends somewhat upon the characteristics of the river. Large streams, like the Susquehanna river, which have a rapidly changing flow, require careful regulation wherever dams are built. Experience at Conowingo and Safe Harbour has definitely proved the value of electric gate heaters even for the comparatively mild climate of southern Pennsylvania.

Fig. 1—Troublesome Ice Formations with Unheated Two-Leaf Gates.

Wherever freezing occurs, ice must be combatted at seals, guides, gate faces and sills. The ice problems are essentially the same for all types of gates and require similar treatment. Air bubblers help to reduce surface ice formation on the pond but heat is also necessary to keep gates in an operating condition. Electric heat has proved particularly suitable for this service and some methods of applying it will be considered.

When gates are opened any adjacent equipment is subjected to powerful water currents, floating ice and logs, so that any heating structure used must be capable of withstanding such conditions as well as exposure to weather. A practical method for heating seals and guides has been found by providing heater wells in the masonry. In some instances this is done by embedding a 4-inch pipe near the roller bearing guide plates and the seals. An even better method is to form the guides of structural steel members so that the roller track forms one wall of a hollow rectangular well. In any case, it is essential to provide suitable heater wells when designing the masonry structure of a dam. These wells must extend from the surface of the dam down to the sill and have drainage holes at the bottom. They do not need to be waterproof at any point, their function being merely to provide a protected space into which suitable heaters may be inserted.

The heaters themselves must be completely waterproof. They give their heat to the walls of the well and it is conducted through the guide plate and the adjacent masonry so that ice will not form where it can interfere with free movements of the gate. Many types of heater construction have been tried but experience has indicated that one of the most practical methods so far developed is to construct sectional, waterproof heater casings of metal tubing of $2\frac{1}{2}$-inch pipe size. The bottom is sealed and the top is closed by a waterproof fitting arranged for threaded conduit connection.

Inside this waterproof casing is located a long flexible heating element manufactured in convenient sections for shipment and field splicing, and consisting of a series of rigid porcelain blocks mounted on a flexible flat metal bar. These insulators have substantial ribs which guide loosely against the sides of the casing. Flexible Nichrome heating-elements extend through openings in these insulators and are safely spaced away from the metal walls of the casing. This construction permits flexibility and avoids breakage in handling or from expansion and contraction. The glazed porcelain insulators readily withstand heat and moisture and no difficulty is experienced with properly installed heaters on 550-volt service.

The pipe casings are carefully fabricated in convenient lengths, thoroughly cleaned inside, and marked for field assembly. After assembly the complete casings should be tested with air under pressure for loose connections. Each casing can then be lowered into a heater well and permitted to hang freely from its top fitting. All inlet openings should be kept carefully plugged until the heating elements are installed so that water and dirt will not get into the heater casings.

As the heater sections are spliced together the electrical circuits are joined by flexible metal bus bars. They are then lowered into the heater casings through a 3-inch threaded opening in the top fitting. The top heater section is provided with a hoisting hook which engages a shoulder in the top fitting of the heater casing so that the entire heater hangs suspended by this hook. This leaves it completely free to expand or contract without strain or buckling. Each insulator is spaced from its neighbour so that regardless of the length of the assembled heating element no insulator has any strain except its own weight. The flat metal strip acts like a backbone to carry all the insulators. Suitable terminals are provided on the top insulator so that it is a simple matter to connect circuit cables from the conduit. After this is done a 3-inch pipe plug is screwed into the top opening, through which the heater was inserted, thus making a water-tight closure.

Fig. 2—Safe Harbour Dam with Heaters Installed in Masonry.

When the heaters are ready for testing all the top plugs should be removed and the heat be turned on for about thirty minutes to thoroughly dry out any moisture which may have condensed inside the heater casings during construction. Each heater should then be tested for insulation to ground. Forty megohms is easily obtained although readings will often run as high as 100 megohms, depending upon the amount of moisture present. Moisture will not break down the heaters but every precaution should be taken to avoid reduced insulation value, particularly when heater circuits are connected to the station ground-indicator system.

It is seldom advisable to connect several heaters in series as this complicates the wiring and in case of circuit trouble in the conduits may cause an improper voltage to be impressed upon some of the heater sections.

Heaters should be arranged in groups of convenient size with a balanced phase load, each group being controlled by an independent switch and fuses. Remote control is desirable so that heaters at any location can be thrown on from a convenient station in the power house.

The complete heating system should be tested early each fall while the weather is still good, each group being isolated and tested with a megger to locate any insulation fault. A check of the circuit loads should also be made.

In addition to heating the vertical gains it is often necessary to heat the interior of gates. The best method is to close in the downstream side with heavy matched lumber and building paper so as to make a closed air compartment. Heaters are then placed inside of this compartment. Interposing this warm air chamber between the cold air and the face of the gate prevents the freezing of heavy ice masses on the upstream face. By locating a considerable amount of heat as low down as possible, the gate bottom can be warmed sufficiently to reduce ice formation where it rests on the sill. This is important so that when the gate is raised it will not pull the sill timber up from its bed. Where gates are heated internally the top and the face above the water line should be covered with matched lumber and building paper to reduce heat losses.

Large rectangular gates of the Stoney type have numerous partitions which serve as structural braces. These interfere with the installation of heaters. Horizontal waterproof pipe heaters of similar construction to those described for the gains may be installed. Some of these should be located close to the bottom so that some heat will be conducted toward the gate sill. Other heaters can be spaced at higher levels according to local conditions and height of water line.

Another method of applying internal gate heaters to this type of gate is to cut a series of vertically aligned holes through the horizontal partition plates and to insert from the top, vertical heater pipes. This arrangement is completely waterproof, is protected against mechanical damage, and has convenient and readily accessible connection fittings at the top. Heaters can be designed so that any section of the vertical heater will deliver concentrated heat at any desired point.

It is, of course, necessary to have flexible connections to carry the electrical circuit from the stationary dam structure to the movable gate. Cables can be connected with plugs and receptacles if care is taken to house them in a suitable shelter from the weather. In some cases it is thought better to make a splice in the cable. If necessary, this can be disconnected and spliced again.

Fig. 3—Inserting Flexible Electric Heater in Curved Pipe Casing.

Taintor gates can be heated in a similar manner to vertical lift gates by installing curved wells in the masonry at the back of the guide plates. Curved waterproof heater casings of the same radius can readily be inserted and the flexible heating elements will slide freely into this curved casing. Conduit connection can be made at the top exactly as for vertical heaters. For the internal heating of Taintor gates the downstream face should be closed in with timber and building paper and horizontal heater pipes installed in the bottom corner of the gate over the sill. Conduit connection from this heater can be brought out to the pivot point of the gate so that a flexible cable connection will have a minimum movement when the gate is raised or lowered.

Motor driven blowers have been tried for circulating warm air throughout gate interiors. By cutting holes through the partition plates, and erecting suitable baffle walls, a complete air circuit can be arranged. This method does not seem to have any advantage over direct electric heating without a blower and appears to have some disadvantages. A motor driven blower located within a gate is not readily accessible and if it fails for any reason, the air circulation ceases. Where heating elements are arranged in a compact group adjacent to a fan the highly concentrated heat is carried away by the rapidly moving air blast but if this ceases for any reason a thermal protection device must function to cut off the heat energy, and prevent local overheating. It would seem that gate heating is too important to depend upon the operation of any automatic equipment, and that if a fan is to be used at all, the heaters should be distributed throughout the interior of the gate in such a way that they could continue to operate satisfactorily in case of interruption to the air flow.

Fig. 4—Waterproof Gate Showing Top Fitting and Heating Element.

Any heater located within a gate should be fully enclosed so as to be waterproof and protected from mechanical damage at all times. In other words, it is advisable to use the same type and location of heaters in a gate whether fan circulation is used or not and it is to be doubted whether anything is gained by using a fan. It only adds to the first cost of the equipment, to the necessity for inspection, and to upkeep. The fan also has the disadvantage of distributing the heat about equally over the downstream and the upstream faces of the gate whereas direct heating permits a better control of heat application through conduction and local radiation to adjacent gate surfaces.

It has also been proposed to heat gates by means of pipes through which electrically heated oil is pumped. A pump has at least as many chances for failure as a fan and the heating of oil is a more exacting problem than the heating of air. Circulating hot oil is a useful heating medium for some types of industrial process work but there does not appear to be any advantage in using it for gate heating. In fact it would be less satisfactory than direct gate heaters in at least three important respects.

Greater original cost;

Less reliability under all service conditions, particularly on the higher voltages;

Greater maintenance and inspection costs.

Waterproof electric heaters similar to those described can be buried in earth or concrete to combat ice. They can be installed in valve pits, surge tanks, air vents, downspouts, risers to water towers and similar places. Straight or curved sections of any length can be installed as easily as steam pipes. Electric heaters never freeze up and require no drainage connections, and where ample power is available they have many practical uses.

There have been many efforts to combat frazil ice by means of electric heat. Experiments have been made by Mr. C. R. Reid at Shawinigan Falls and somewhat similar work has been done on a smaller scale in the United States. The best method seems to be the one used by Mr. Reid, which was to connect the steel trash-rack bars in series with each other, using wooden timbers for insulating spacers. A high current was passed through these bars so that they served as resistors. It is, of course, impossible to raise the temperature of the river itself but ice is a comparatively good heat insulator. When it starts to form on the surface of the bars it shields them from the cold water and their surface temperature is raised sufficiently to loosen the ice film.

This method requires the installation of large transformers and while in operation may require a considerable proportion of the station output, but it will undoubtedly prevent blocking of the intake bars. Fortunately this type of ice condition occurs for rather short and infrequent periods so that as a matter of insurance against shut-down the installation may sometimes be justified. It is believed there is no other way in which heat can be successfully applied to combat this troublesome ice problem.

The Heating of Power Houses, Substations, Etc.

There is a great deal of waste heat from generators and other electrical apparatus, some of which can be utilized to advantage for heating purposes. Where attendants are always present it is possible to regulate manually the delivery of hot air from electrical equipment for room heating, but this can be more satisfactorily accomplished by automatic regulation. A thorough air circulation is necessary in order to distribute and equalize the heating effect, and in some cases waste heat from electrical machinery can be conveyed to other rooms for heating purposes. When there are periods in which little waste heat is available combination systems can be arranged which normally utilize waste heat but call upon auxiliary heaters when necessary.

Some hydro-electric stations use large portable electric fan heaters, mounted on wheels so that they can be rolled into position, and connected by cable and plug to stationary receptacles. Heaters of this kind should have built-in automatic control, mounted with the motor, on the cool air intake side. These heaters are also useful for emergency heating purposes, such as drying out wet machines. In other stations heaters are mounted on the walls at various locations so that they can be started when needed.

A completely automatic system has recently been designed which will bleed from the generators just enough waste heat for the winter heating requirements, regardless of varying weather conditions and generator loads. This heat will be thoroughly circulated by blowers handling a total of 36,000 cubic feet per minute. Auxiliary electric heating will be installed to take care of certain emergency conditions.

An outdoor supply of fresh air will be introduced under selective automatic control when required for cooling the building. This will vary in volume as required, up to a maximum of 36,000 cubic feet per minute. All of this equipment is completely automatic and will function properly without any manual operation. Both heating and cooling of a large building will be accomplished at an expenditure of about 10 h.p. for driving the blowers.

Unattended substations which do not produce much waste heat can best be heated by fan circulation electric heating units. Automatic control is absolutely essential for economical operation and because no attendant is regularly present, it is not necessary to consider human comfort. The essential thing is to prevent condensation during certain weather conditions. The comfort of inspectors or attendants when they are present can be provided for temporarily. A special form of automatic control known as "dewpoint control" has been devised for this service. It is a type of thermostat having a bulb sensitive to indoor air temperatures and an extension through the wall with a bulb sensitive to outdoor air temperatures. These two bulbs co-operate to produce a resultant indoor temperature which varies, but keeps 15 degrees above the outdoor temperature. If the outdoor temperature is 20 degrees above zero the indoor temperature will be 35 degrees but if the outdoor temperature rises to 45 degrees the indoor temperature promptly goes up to 60 degrees.

Condensation forms on the interior walls of a building and on electrical machinery exactly as dew forms out of doors. This happens when warm, moist air comes in contact with colder surfaces. In a substation the walls and equipment get thoroughly chilled during long cold spells and when these are followed by a sudden warm, damp spell, fresh air entering the building comes in contact with colder surfaces which lower its dewpoint and moisture is deposited. This variable form of dewpoint control is essentially an economy device. Inasmuch as a constant temperature for comfort is not necessary in an unattended station, advantage can be taken during cold weather to make a decided saving in power for heating, by allowing the internal temperature to drop. This would not be possible without some way to raise the internal temperature promptly when the outdoor air grows warmer, but with a variable control a heating system can be safely maintained on a 15-degree temperature difference.

The Heating of Buildings

Electric heat is often suitable for offices and other buildings besides electrical stations, but each project must be studied in relation to rates and to the available power supply. A given installation may be entirely justified in one case and quite unwarranted in another. Large single-phase loads are undesirable but balanced polyphase heaters are available for any voltage.

Many rate schedules include a demand charge based on total connected load. This places a considerable burden upon electric heating if it is only used during a few months of the year. It is not so serious for industrial processes that are used constantly and it actually works in favour of electric heating wherever power can only be used during "off peak" periods when industrial load is at a minimum. Even where rate schedules do not offer direct inducements to use "off peak" power by special low rate steps any user can benefit through avoiding added demand. This can be done by arranging his operating schedule so that the heating load will never be superimposed upon other loads, thus not exceeding at any time the normal demand which other equipment obliges him to pay for. When this is done it is only necessary to pay for the actual cost of the power consumed in heating and at the sliding scale of rates which are customary for industrial plants, this heating load will usually fall into a favourable bracket.

Considerable mistaken effort has been made attempting to sell "off peak" power for electrically heating homes by storing heat in tanks of water. Several factors serve to discourage this method for buildings which normally require a comparatively small power service. While this heat storage method could fit into the generating "off peak" periods, ordinary buildings are not served by distribution lines capable of supplying the heavy power required during the heat storing periods. It is also difficult to adjust the heat storage to suit quick variations in weather. Efficiency may be fairly high on a cold day and exceedingly low on a mild one. This disadvantage is not shared by competing types of modern automatic fuel systems. No way of storing electric energy has yet been found comparable to the energy stored in oil or coal.

However, the principle of utilizing "off peak" power is perfectly sound when properly applied. When studying the economic possibilities of "off peak" electric heating, the existing power service must be considered. Industrial plants with a heavy motor load can often use large amounts of power for heating purposes, during periods when other equipment is shut down. This does not cause any increased demand and considerably improves the plant power factor.

As an example, a large paper box factory in Philadelphia has its own printing room located on the fourth floor. The rest of the building is used for storage or for rough work requiring little heat, but the press room has to be heated at all times. If this room is allowed to cool at night, trouble is experienced in the morning with the printing processes.

Two years ago it was decided to install 50 kw. of auxiliary electric fan heaters in the press room. The motor supply service was ample to carry this load so no extra wiring was needed. The boilers in the basement were shut down at night and over week-ends. The press room was satisfactorily heated at night to 60 degrees F. with a decided saving over the cost for a night fireman and fuel.

Carefully planned "off peak" auxiliary electric heating of this kind deserves consideration from power companies and industrial engineers. Most large plants, if properly surveyed, would reveal possibilities for its economical use.

For large rooms fan circulation electric heaters are usually installed on the walls. Combination steam and electric units are frequently used. Small rooms and offices are usually heated by compact heaters set on the floor to deliver a gentle current of warm air without drafts.

Electric heating is well suited for central fan duct systems of heating and ventilating and numerous installations have been made in moderate size office buildings. The blower can be located in a penthouse on the roof or in the basement. Fresh air supply is taken in through a heating chamber and each branch air delivery duct has its own individual heater. Return ducts to a mixing chamber permit any desired proportion of recirculation.

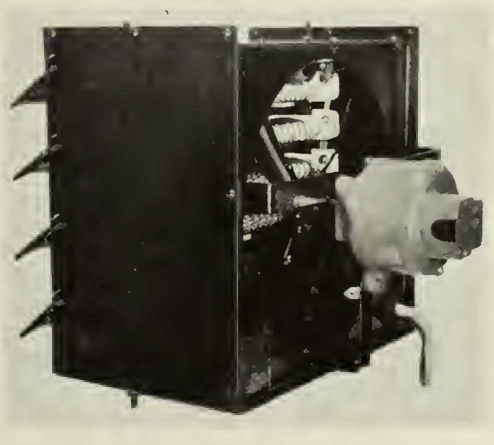

Fig. 5—Fan Circulation Electric Unit Heater.

Special automatic control is necessary for a duct heating system. It is not satisfactory to throw the heat on and off by an ordinary thermostat, because this would produce alternate blasts of hot and cool air. It is absolutely necessary to vary the heat input and accurately adjust it so as to maintain a uniform temperature of air flow regardless of its volume or of weather conditions. In some cases the mixing dampers controlling the volume of fresh air supply are manually adjusted but in other cases they are automatically regulated. When this is done the control must be co-ordinated with the control of the heater input. Heaters are arranged in balanced stages and the control automatically selects the heat stage which most nearly balances the demand for heat.

Electric heaters are often used as auxiliaries to steam heaters in duct systems during mild weather. By properly locating them in local branch ducts, individual rooms can be heated without starting up the boilers.

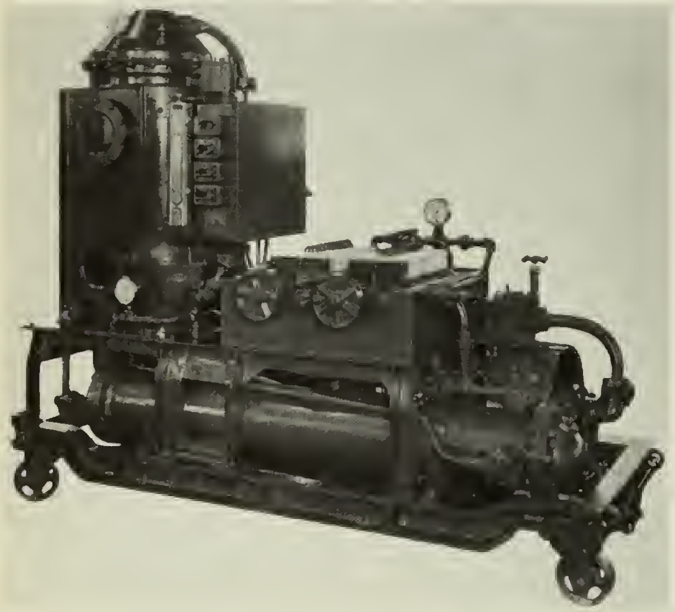

Fig. 6—Electrically Heated Vacuum Oil Purification Machine for Cable Oils.

Duct systems are often designed for heating in winter and cooling in summer. Where a sufficient supply of cool water can be obtained from deep wells a spray chamber will provide adequate summer cooling and complete year-around air washing. Electric heaters installed in the same duct system will provide for winter heating or they can be used as auxiliary to steam heating. Many combinations can be worked out but all require careful engineering and adequate automatic control.

Reverse cycle refrigeration equipment has sometimes been referred to as a form of electric heating but this is not strictly correct, although the heat energy delivered may be as much as two or three times the kilowatt power input required to drive the motor. However, heat is simply pumped from one medium to another and exactly the same result can be obtained by driving the equipment with an internal combustion engine instead of an electric motor. This reverse cycle equipment is an interesting and useful process, which would appear to be most useful in moderate climates where the winter heating requirements are approximately equal to the summer cooling requirements, as the efficiency of the heating cycle falls off rapidly with low outdoor temperature. Equipment of this kind may have a practical use as a means for salvaging low temperature waste heat from industrial processes, thus reducing overall thermal loss.

Industrial Heating Processes

Industrial process work offers a large field for electric heating wherever steam is not available or where temperatures are required outside the range of saturated steam.

Electric heaters have a constant energy input and their surface temperature depends on the rate at which heat is taken away from them. In this respect they are entirely different from steam where the temperature remains constant for a given pressure, but the condensation rate changes according to demand.

Direct applications of electric heaters are difficult to control where demand for heat fluctuates rapidly or for materials of low conductivity. Many materials can best be heated in tanks or vessels by large banks of radiation heaters mounted adjacent to their walls. This gives a uniform input of heat over large areas so as to maintain low heat density and the interior of the vessel is kept free from obstructions. Heaters of this construction are suited for high voltage polyphase circuits and can be arranged in balanced steps to permit variations of heat input. A proper design of vessel with good heat insulation is always necessary.

Pitch is successfully heated by this method in large vertical or horizontal tanks. In coating steel pipe the comparatively thin walls do not require pre-heating. The pipe is dipped cold and is heated by immersion in the hot pitch. This produces a very superior coating as the pitch temperature can be accurately controlled and volatile constituents are not wasted.

Cast iron pipe requires a different process owing to its heavy walls. It should be preheated to approximately the pitch temperature before dipping. A unique installation has recently been made where the pipe is preheated in a gas oven, then dipped in an electrically heated pitch tank. This continuous process permits large production with a very superior quality of coating. Electric heat can often be used for the accurate key part of a process while the bulk of the heat input is obtained from some cheaper and less responsive source.

Large tanks of water are often heated by installing heavy welded tubes with internal heater elements similar to those described for gate heating. The large tube surface permits heavy ratings and the heater design is well suited for high voltages. All electrical parts are easily inspected or renewed without draining the vessel. Large tanks of heavy oil can also be equipped with similar heaters of low surface density, to reduce viscosity and permit flow in cold weather.

For heating oils to high temperatures a more refined method is necessary. Oils have comparatively low rates of thermal conductivity and sluggish convection currents. The temperature gradient of the heater must be kept as small as possible, and a positive uniform flow must be maintained. The heating elements must have a minimum of heat storage capacity to prevent carbonizing the oil from stored heat when flow stops due to shutting down the process.

Uniform flow over all surfaces cannot be secured with ordinary immersion heaters nor with tube heaters as described. A successful method has been found by arranging a series of narrow, flat, staggered passages having walls constructed of thin heater sections. Oil is pumped through these passages so that any desired rate of flow is assured.

This method is widely used in preparing insulating oils for centrifugal purification. It is also used in heating oil baths for tempering steel. Hot oil is a good high temperature medium for heat transfer with coils or jacketed vessels. Special oils are used and pumps, automatic control, expansion tanks and piping must be properly designed, but temperatures up to 600 degrees F. are successfully used with not more than 20 pounds per square inch pressure. This extends the temperature range for jacketed aluminum and copper vessels beyond that permissible for steam, and removes all hazards due to high pressures.

There are many other uses for circulating hot oil. One is for high temperature platens of hydraulic presses, where steam pressures up to 800 pounds per square inch are sometimes necessary. The serious problem of making flexible connections is simplified by using hot oil at 25 pounds pressure.

Sulphur is a poor conductor of heat but large batches can be melted safely by hot oil pipes spaced through the mass. Hot pipes have also been formed into revolving agitators to distribute heat through heavy materials. Vessels heated by steam jackets or coils can often be quite easily converted for oil heating. Hazardous chemical processes are more safely heated by hot oil than by direct firing. Temperature control is also much more accurate.

Electric heat is useful for many drying processes. Radiant reflector heaters can be used above the moving surface of silk and cotton fabrics in dye works and over plate glass travelling from the washer in making laminated safety glass.

Many industrial processes can be improved by using electric heat and automatic control, but in each case careful planning is required. Unless the job warrants being done well, it is usually wiser not to do it at all. There are so many variables in electric heat engineering that successful performance is seldom the result of chance.

Heavy Forgings and the Use of Alloys

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Paper presented before the Niagara Peninsula Branch of The Engineering Institute of Canada, May 2nd, 1935, on the occasion of a visit to the Canada Forge Plant of Canada Foundries and Forgings Limited, at Welland, Ontario.

Forging of metal, in one form or another, is one of the oldest arts known to man and there is evidence that iron was well known to the Assyrians, Chaldeans and Babylonians, long before the time of Christ.

Though the use of iron was widespread, it was considered by the ancients as a rare and precious metal. This was not due to the scarcity of ore but to the difficulty in smelting it. The iron workers of ancient days made iron in a hole dug in a hill-top. A tunnel was then dug through the side of the hill to the bottom of the fire-hole. The wind rushing through the tunnel gave the required draught, but the difficulty with melting in this sort of furnace was that it could be used only on windy days. Finally in Catalonia, Spain, the Catalan forge was made and was the standard furnace for making iron during the Middle Ages.

Steel implements must have been used in the construction of certain of the earliest ancient monuments but little is definitely known of the method of making steels in ancient times.

The famous steels of Damascus and Toledo were made by a crude form of crucible process but this method was lost during the Middle Ages and was not re-discovered until 1842 when Benjamin Dustman, an English watchmaker, found that by breaking or shearing small pieces of "blister" steel and melting them in a clay crucible, he was able to obtain a steel which when worked up into watch springs served in a very satisfactory manner. This was crucible steel and was very popular until the advent of the Bessemer and open hearth processes.

The first open hearth furnace in the western hemisphere was built at Trenton, New Jersey, in 1865 and had a capacity of five tons requiring from seven to eight hours to complete a heat. Five years later a second open hearth furnace was built at South Boston, Mass. All heats were tapped on a fracture test, as laboratories were then unknown. The pig iron and manganese for these early open hearth furnaces were imported from abroad and it was not until the early seventies that steel mills in this country made their own ferro-manganese.

In 1872, the Quebec Steel Company of Quebec had a three-ton open hearth furnace making tool steels. In the early days of the open hearth furnace, twenty-five to forty-eight heats constituted a satisfactory "run" for a furnace while today the modern open hearth furnaces, manufacturing forging quality steel ingots, ranging in capacity from thirty-five to one hundred and fifty tons, turn out from 500 to 800 heats at a "run" without major repairs. The average time required for producing a heat in the modern furnace is from ten to twelve hours.

Fig. 1—Mine Hoist Drum Shaft Forging under 600-ton Hydraulic Press from 48-inch Ingot part Forged at this Point.

The first forging tools known to man were the hand-hammer and the anvil. With the progress of civilization the limitations of these tools were recognized and with the development of uses for heavy iron and steel tools, implements, machinery and equipment, the power-hammer came into being. The first power hammers were of the helve or trip types, usually operated directly from the shaft of a water wheel.

The steam hammer as invented by James Nasmyth in 1842 was direct acting and a decided improvement over the trip and helve types, but was defective in several ways. The valves were operated by hand and it was often difficult to raise the ram immediately after a blow was struck. This had a tendency to chill the metal being worked on the die. The steam hammer remained in this state until Robert Wilson applied a valve motion which enabled the blows to be regulated both in speed and force, thus placing the hammer absolutely under the control of the operator.

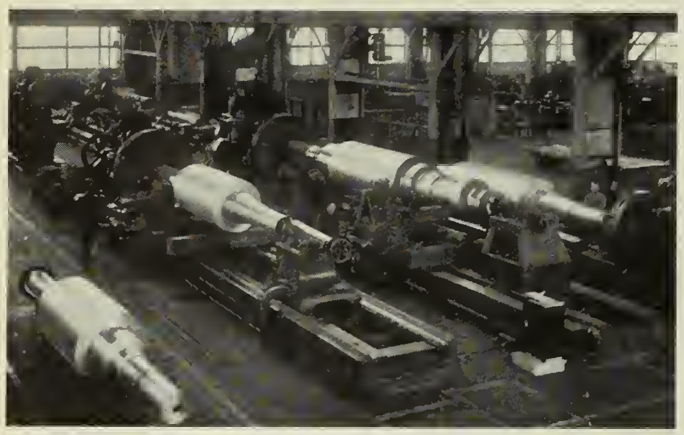

Fig. 2—Steam Turbine Generator Shafts .45 Carbon Steel, Annealed 52-inch diameter of Shaft. Weight 96,000 Pounds Each.

The steam hammer has been a potent factor in the development of the steel industry and today is but slightly different from those made by Nasmyth and Wilson. The improvements made since it was originally invented have been mostly on the valves, the guides for the ram and the general construction of the frames. The smaller sizes are of the single frame type, while those intended for heavy forgings have an arched or double frame.

Later, as further developments in machinery progressed, larger forgings were specified and in order to meet this growing demand the forging press was developed to handle this heavier work.

There are two general types of forging presses in use. First, the regular hydraulic forging press, in which the water pressure is furnished by independent pumps. Second, the steam-hydraulic press in which the hydraulic pressure is produced by means of a steam intensifier. The former type is not now used to as large an extent as the latter, which has a number of advantages over the simple hydraulic type, the principal of which is rapidity of operation.

The power of a hand-hammer is not derived from its weight alone but from weight combined with velocity and the same is true of all kinds of drop-hammers. The power of a drop-hammer depends solely upon the mass of the hammer and its lift, whereas certain types of hammer operated by steam or compressed air obtain additional power by increasing the acceleration beyond that caused by gravity alone.

There is a field for both the drop and the steam hammer as well as the forging press, the former appliances being most suitable for small work, and the forging press for large work. The reason for this is, that small pieces cool quickly and as a rule require a finer surface finish than is demanded in large forgings. Since the hammer strikes a blow, the penetrative force of the impact increases as the forging cools, so that work done on the surface of the forging even when it is quite cool affects the axis of the piece, otherwise the work of a hammer is most effective on the surface. The press, on the contrary, would be powerless to do any work on cold pieces unless the anvil surface was greatly reduced. Thus the hammer will probably always be used for small work and for making tools. However, the features which make the hammer desirable for small work, make it undesirable for large work. The hammer acts upon the surface of the material driving the surface over the core without compressing the latter. The press, on the other hand, exerts a continuous pressure which forces the semi-fluid material at the axis of the forging to flow under compression, which process tends to increase the density of the material. It is thus evident that from the standpoint of improving the quality of the material in forgings, the press is superior to the hammer and would be considered even more useful if under equal conditions it consumed less steam than a hammer. The press is definitely easier on the cranes and other tools used at a forging unit.

There are three means of working hot metal into shape: the hammer, the press and the rolling mill. When speaking of forgings the rolling of the steel is usually overlooked, but the bulk of the steel tonnage used in industry is really turned out by this process.

Alloy Steels

About the end of the nineteenth century alloy steels were developed when it was found that when certain elements were added to ordinary carbon steels a wide range of improved physical properties were obtainable, including much greater strengths. In the majority of cases, heat treatment is necessary to bring out these advantages. Alloy steels untreated are usually brittle and unsatisfactory.

Alloying elements used in steels for forgings may be divided into three groups, based on whether or not the element is completely dissolved by the iron or ferrite, combines with the carbon to form a carbide in the pearlite or is partly dissolved by the iron and partly forms a carbide, thus strengthening both the pearlite and ferrite. Such a classification can at best be based only on the general affinity of the alloying element for carbon, since both the amount of the carbon and the alloying element present determine to a considerable degree whether the alloying element will be dissolved by the iron, combine with the iron or both. Elements which are dissolved by the iron generally increase the strength and toughness of the steel and those

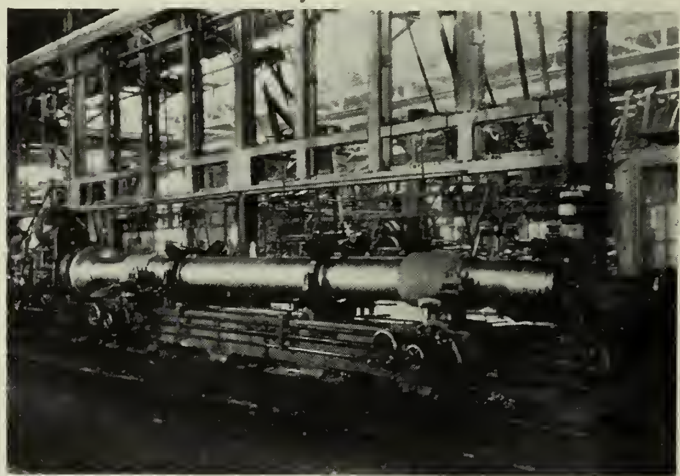

Fig. 3—Noranda Hoist Shaft. Weight 31,180 pounds.

which combine with the carbon to form carbides increase the hardness, therefore elements which are partially dissolved by the iron and also form carbides have the general tendency to increase both the toughness and the hardness. The prevailing practice is to use two alloying elements, one to build up the strength of the iron or ferrite, the other to strengthen the pearlite by the introduction of carbides.

Nickel

Nickel is one of the two most widely used alloying elements in machinery steel, but is little used in tool steels.

Its principal use is in large forgings where toughness and strength are required and is outstanding because of the fact that it combines with or is dissolved by the iron in any proportion and does not normally form a carbide. Therefore, as would be expected, nickel increases the strength and toughness of the steel without materially increasing the hardness. The nickel content of commercial nickel steels in forgings varies and is effective from one-half of one per cent up to about six per cent. Each one per cent of nickel up to five per cent raises the tensile strength about 5,000 pounds over the corresponding carbon steel without loss of ductility or material increase in hardness. In non-magnetic steel, corrosion resisting steel, and heat resisting steels, the nickel content may reach 60 per cent.

Chromium

This element may be used in forging steels in the range from one-half per cent to two per cent. It adds strength and hardness by the formation of carbides. In forgings, it is generally used with nickel, vanadium or molybdenum and gives its best results in material which is to be quenched. Its use in connection with nickel for heat and corrosion-resisting materials has proved to be absolutely necessary.

Vanadium

This is the most expensive of the ordinary elements used in steels. It is used in smaller amounts than the other alloys and the effect of adding as little as .05 per cent is distinctly noticeable. The use of more than .20 per cent vanadium does not appear to be particularly beneficial in machinery steels. Vanadium was first used as a scavenger or cleanser in the molten state but it is now well recognized that the properties it imparts to steel are due chiefly to its effect when present in the steel as an alloy. The presence of vanadium produces fine grain, probably by promoting simultaneous crystallization on many nuclei or centres as the steel passes through the solidification range and the transformations in the critical range. Carbides containing vanadium diffuse less rapidly than when the vanadium is not present; hence steels with this element have to be heated to higher temperatures to obtain diffusion than in the case of plain carbon steels. A mere "pinch" of vanadium in almost any alloy steel so retards the growth of austenite grains that the leeway in heating for annealing or quenching is greatly increased and the danger of brittleness resulting from heating the steel too hot or heating too long is minimized. The benefit from the presence of vanadium is intensified when chromium is present; consequently, excepting in the carbon vanadium steels, vanadium is nearly always supported by chromium. Vanadium itself adds little to the strength of steel except that due to reduced grain size the yield point and elastic limit are higher. From .15 to .20 per cent vanadium is added to straight carbon steels to obtain greater toughness, uniformity, resistance to grain growth when overheated, and to decrease the danger of breakage when water quenched.

Molybdenum

Molybdenum was used as an alloy in some of the old self-hardening crucible steels previous to 1880. In these steels it replaced the tungsten or rather, a part of the tungsten. It is a carbide former, increases the hardness and affects the critical points all in the manner of tungsten and also increases the depth effect of heat treatment. It is used as an alloy in machinery steel in amounts up to .50 per cent and usually in combination with other alloys such as chrome or nickel, or both. The tendency to temper-brittleness so prevalent in most combinations of nickel-chromium steels is retarded or minimized by addition of molybdenum in amounts of .20 to .50 per cent.

Manganese

Manganese is necessary in alloy and carbon steels and is added to all steel because of its effect as a scavenger in removing gases and their products, and in order to combine with the sulphur and obviate the harmful red-short effects of sulphur. Manganese adds toughness and strength to low carbon steels by retarding precipitation when hardened. In large size forgings used in the normalized condition, the so-called intermediate manganese steel (i.e. 1½ to 3 per cent) is somewhat erratic under heat and requires special care in forging. The value of manganese as an alloy is increased by combining with it another element such as vanadium, nickel or molybdenum. With either of these

Fig. 4—Hydraulic Turbine Shafts. Hydraulic End .45 Carbon Steel Annealed.

elements supporting the manganese, very satisfactory normalized and tempered forgings can be produced. Such forgings are used in considerable number for locomotive driving axles, crank pins, connecting rods, etc. Normalizing is the reheating of the steel after forging and subsequent cooling, usually in still air, to refine the grain structure and relieve forging stresses. This improves the quality and strength of the steel as well as its machineability.

Silicon

Silicon is used in practically all commercial steels as a deoxidizer but its use as a true alloying element has been limited in machinery steels. Silicon is not used as an alloy in forging quality steels.

Heavy Forgings

The production of a large forging really starts when the engineer designs the finished machine or tool in which it is to be used. The design of the forging, as well as the dimensions, is thus determined beforehand. In some cases the physical properties required of the finished forging are given to the steel and forging maker, who decides of what class and kind of steel the forging should be made to give the desired results. In other cases only the chemical analysis is supplied the steel maker and he makes the steel and forging to this specification.

After the kind of steel to be used is settled, the next question for the forge man to decide is the weight of steel necessary to make the forging, the size and weight of ingot and the type of ingot mould the steel shall be poured into. After these questions have been decided the actual manufacture of the steel ingot begins.

The rapid development of power plant equipment, the greater size and speed required for propulsion machinery for ships, the increased size of paper mill machinery, mining machinery and parts such as crankshafts for forming presses for the mass production of automobiles, all call for larger forgings of both straight carbon and various alloy steels. Serious accidents such as the bursting of rotor bodies while running at great speeds are of rare occurrence and this is due to the proper selection of the quality of steel and the size and type of ingot used, and to the proper forging, heat-treating and machining of the forgings designed for these jobs. Similar care along the same lines is applied to forgings for service in aero engines, automobiles and locomotives.

Homogeneity as regards the composition of the ingot, freedom from defects and permanence of properties are essential in the case of large forgings and are attained only by following the best metallurgical practices based upon long experience with special forging steels. The manufacture and casting of the ingot is done under complete technical control. This insures proper melting and refining

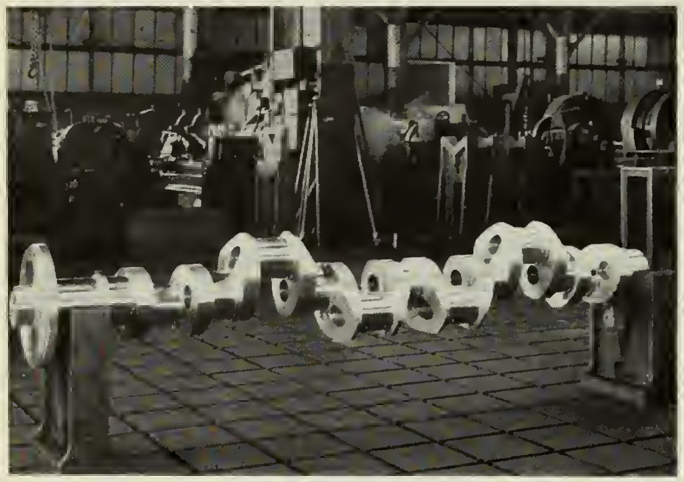

Fig. 5—No. 2 Light Weight High Speed Diesel Engine Crankshafts Chrome Nickel Molybdenum Steel, quenched and drawn to test 115-95-20 and 50.

conditions, casting temperature, teeming speeds and so forth, the metal used being produced from selected scrap materials treated by the basic or acid open hearth processes. The cast iron moulds into which the steel is poured are of special composition and design and these are cleaned, coated with graphite and pre-heated carefully before the steel is poured into them. They also have large refractory-lined hot-tops to prevent the possibility of gas pockets or mechanical troubles due to shrinkage effects located in the utilized part of the ingot. Sufficient material is discarded from the top and from the bottom of the ingot to insure perfectly sound material in the forging and to eliminate the zones of segregation set up during the solidification of the metal. The removal of 30 per cent of the total weight from the top end of ingot is required by many specifications and satisfaction of quality requirements often necessitates discarding as high as 50 per cent from the top and 10 per cent from the bottom of the ingot.

After the ingot has been poured the subsequent processing moves on a pre-determined schedule. Many of the problems of heavy forging manufacture are problems of handling, and extensive equipment such as cranes, manipulators, forging presses, porter bars, cutting tools, soaking pits and forge heating furnaces, heat-treating and annealing furnaces, turning and boring lathes and planers, is required.

When the poured ingot has thoroughly set, it is stripped and placed in an air-tight soaking pit on the pouring floor where it is permitted to soak or equalize for several hours without the addition of external heat and is thus allowed to attain a uniform temperature throughout at about 1,000 degrees F. Entering this pit with the interior perhaps 500 to 1,000 degrees F. hotter than the exterior, the gradual equalizing of the temperature prevents the contraction strains which might otherwise be set up if it were allowed to cool rapidly to atmospheric temperature, or what is even more serious, the development of hot tears or shrinkage discontinuities at the axis of the ingot; thus an ingot is produced which is uniform in structure.

The ingot is then put into an oil-fired soaking pit in the forging department, where it follows a definite pre-arranged schedule of heating in which the specific temperature, hour by hour, is rigidly stipulated. As an example, an ingot is brought slowly to say 1,400 degrees F. and held there for several hours without change. It is then brought up in steps of 75 to 100 degrees per hour to the final forging temperature of 2,100 to 2,300 degrees, depending upon the carbon content. These schedules are all worked out to avoid strains in the steel while passing through the critical temperature range and to assure the axis of the ingot being thoroughly soaked at the prescribed temperature. A medium sized ingot, say of 42 inches cross section, would be fired forty-eight hours, while an 80-inch cross section is fired ninety hours before it is considered ready to forge.

Upon reaching the forging press, the piece again finds a definite schedule of operations awaiting it. A blueprint furnished the head pressman shows exactly the amount of reduction to be made for each heating, while general instructions state the reduction to be made at each impression of the press before the piece is turned around and squeezed in another direction. Observance of these directions prevent the trouble so often experienced in small diameters, of opening up the centre of the ingot into a four pointed star-shaped fissure. The reduction is so gradual and the piece rotated so frequently that it is impossible for the fibres to tear themselves apart as occurs in less careful forging. Under this press, which varies in different plants from 250 tons to 2,500 tons capacity, it is possible to handle ingots ranging in size from 23 inches in diameter and 19,000 pounds in weight to those 80 inches in diameter and 170,000 pounds, while a 12,000-ton press works an ingot 108 inches in diameter and 400,000 pounds in weight.

After large carbon steel forgings of 40 inches or over in diameter and alloy steel forgings under and over 40 inches in diameter, have been finished forged, they are buried in ashes or placed in a warm furnace to protect the piece from draughts, etc., until a temperature under the Ar critical is reached throughout the section. They are then taken to the treatment furnace and uniformly reheated to a temperature sufficiently above the upper critical range to break up the ingot structure, held the necessary length of time and then withdrawn and air-cooled under closely controlled conditions, protected from moisture. Upon being cooled to a black state, the forging is reheated to a low annealing temperature, held the necessary length of time and uniformly slowly cooled. The forging is then given a preliminary rough machining all over, including the rough boring of the axial exploration hole in the case of a bored forging. It is then recharged into a cold furnace and reheated to a temperature above the upper critical range to refine the grain, held the necessary length of time, and withdrawn and air-cooled under closely controlled conditions, protected from moisture. Upon being cooled to a black state, it is reheated to a low annealing temperature, held the necessary length of time and uniformly cooled.

The forging is then rough machined to the dimensions of the purchaser's drawing, after which, to assure stability, it is again charged into a cold furnace, reheated to a temperature of not less than 1,050 degrees F., held for a sufficient length of time and cooled slowly in the furnace to remove surface stresses set up by machining. No further machining other than cutting off test specimens or finishing the bore of the axial hole in the case of bored forgings, is to be performed after this final annealing. Most large diameter forgings are bored along the axis and explored with a periscope to assure absence of discontinuities which might originate at the solidification of the ingot or during subsequent heatings or coolings.

Forgings less than 40 inches in diameter may be treated in the same manner as outlined in the foregoing; or the sequence of heating and machining operations may be varied, depending on the size and shape of the forging.

but in any event, the forging is heated twice to a temperature above the upper critical range and air or furnace-cooled, and after all rough machining has been completed, it receives a final low temperature annealing at a temperature of not less than 1,050 degrees F., and is slowly cooled in the furnace. In the case of a bored forging, the axial exploration hole is bored at any stage before the final annealing operation.

Most of the heavier type of forgings delivered to machinery builders are furnished by the manufacturer in the rough machined state with possibly the exception of large crankshafts, which are more often furnished ready for installation.

There are now Canadian plants capable of producing heavy forgings from ingots up to 42 inches in diameter and 44,000 pounds weight, and to any desired chemical or physical specifications. This range covers ninety per cent of all Canadian requirements, it being only necessary to import a few specially large forgings, for which the demand is so limited in Canada that it would not be economical to provide the expensive equipment necessary for their production.

Canadian steel mills furnish ingots up to 20 inches in diameter, in both carbon and alloy steels, ingots of larger size or special composition being purchased in England or the United States.

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Low Cost Housing

In the thickly populated countries of Europe the problems of housing and the removal of slum conditions have been before the public and Legislative bodies for many years, and naturally have received more attention than on this side of the Atlantic. In July of this year the International Housing and Town Planning Congress met in England, where its delegates were able to visit many industrial centres and see the results of long-continued effort on the part of both public and private organizations. The housing estates and cottage homes at Bolton, the slum clearance schemes of Leeds and Manchester, the flats and arterial roads in Liverpool, and the remarkable post-war developments in Birmingham showed the advances which have been made in dealing with these pressing questions. In Britain house construction is being carried on on a very large scale, nearly two and a half million dwellings having been built since 1919. Great progress has also been made in Germany and there has been marked development in the United States, although it has not extended over so long a period as in England. It is estimated that the United States will need ten million homes during the next ten years, and much study has been given to the subject, culminating in an immense housing programme financed by the Government under the Federal Housing Administration.

In Canada the problem has not yet been attacked as a whole, although there have been a number of local schemes. It is encouraging to note the public and governmental interest which has now been aroused, thanks to the efforts of such bodies as the Town Planning Institute of Canada, the National Construction Council of Canada, the Royal Architectural Institute of Canada, and a number of Boards of Trade and similar bodies throughout the country. Surveys have been made of the situation in Toronto (by a commission under Lieut.-Governor Bruce), in Montreal (by the Board of Trade and the City Improvement League), and in Halifax, Saint John, Winnipeg and Vancouver and elsewhere by local housing committees. In this country the number of people affected by improper living conditions is, of course, much smaller than in Britain, Germany or in the United States, but our authorities are agreed that the situation here is a serious one. Recent reports lay stress on the uncoordinated growth of our cities, the overcrowding due to the shortage of dwellings, its effect on the public health, and the unemployment which has resulted from failure to undertake the programme of repairs to existing dwellings and the construction of new ones which is so long overdue.

The need of legislation on this subject has long been realized, and, particularly since the war, a number of provincial and federal housing acts have been placed on the statute books. Definite action was taken this year by the Dominion government, and the latest information in regard to all phases of the question will be found in the final report of the Special Committee appointed to consider and report upon the inauguration of a national policy of housing, which was presented to the House of Commons on April 16th of this year. The Canadian Housing Act followed, under which the Government is prepared to advance part of the cost of homes or apartment blocks. While the provisions of the Act will no doubt facilitate the financing of homes of moderate cost, they do not appear to afford adequate assistance in the case of the lowest paid groups of workers. Wage earners who receive over a thousand dollars a year and who can afford to pay from a quarter to one-third of their income as rent without undergoing serious privation as regards food and clothing, will, it is believed, be able to benefit from the Act, but there exists in every large city a group of workers (largely unskilled), whose annual income is six hundred dollars or less. If the families of these workers are to have adequate food, fuel and clothing, they cannot afford more than about one-fifth of their income in rent. Evidently it is necessary to provide accommodation for them which can be rented at about ten dollars per month and which will replace the unsatisfactory dwellings in which many of them are now living. The Bureau of Statistics has estimated that there is at present a shortage of fifty-five thousand new houses in Canada, to which must be added the number of dwellings required for the newcomers who annually increase our urban population, and the construction needed to put in proper condition otherwise suitable dwellings which have been allowed to deteriorate. Possibly one-third of this total would be needed for the lowest paid group of wage earners.

The difficulty that first arises in this case is that under existing legislation the prospective owner must be prepared to put up twenty per cent of the total cost himself, and pay five per cent interest on the remainder, conditions which cannot be met in the case of the very class whose need for improved housing is the greatest. Further, the problem is more complex than appears at first sight. It is tied up with unemployment, the incidence and amount of taxation, the lack of adequate city planning, land values, construction costs and methods, the habits, standards of living and tastes of the people affected, the public health, provision of the necessary utilities, the requirements of city building regulations, and many other considerations.

The Bruce report found that in Canada, under present conditions, the minimum cost of a suitable dwelling for a family of five is such that if as much as twenty dollars a month rent could be paid, this would only provide a proper return on one third of the total cost of the building and land. Thus, if the present cost of housing cannot be greatly reduced, this difference for the lowest wage groups must be met by a subsidy from federal, provincial or municipal authorities. The need of such financial assistance is generally recognized, and to quote from the Federal Housing Report, "the prevailing opinion would seem to be that the community as a whole has some responsibility for the housing of its people."

In order to reduce the amount of the subsidy required, efforts are being made in all countries to diminish the various items which enter into housing cost, and particularly to find out how to provide a dwelling or an apartment for a family of five which can be rented by the lowest paid wage earner. The matter is not simply one of the construction cost of the building itself. Other items must be considered. For example, the unit cost of land can be reduced by constructing large apartment blocks for those who must live in the city near their work, and by developing economically laid out community sites for those whose work can be transferred to the outskirts of the city. Incidentally, it has been suggested that in many cases suitable areas of land which have reverted to our cities by tax sales, could be replanned and used in this way. Proposals have been made to lessen the tax burden on low cost house property by exempting improvements from municipal taxation, as has been done with great success in England in the garden cities of Letchworth and Welwyn. Again, a properly planned housing area can be provided with facilities and amenities at a much lower cost than if the homes are built on individual lots in different parts of the city. This offers a further possible source of economy.

But even if savings are effected in these and other ways, the stubborn fact remains that the present cost of building construction is so high as to prevent the building of homes for the lowest salaried groups. Attention is therefore being directed to the possibilities of obtaining reduction in cost by the pre-fabrication of houses, the constituent parts or units being factory-made and assembled on the site. It is urged that in this way the benefits of mass production can be obtained, and considerable activity along these lines is being manifested in the United States. It would appear doubtful, however, whether in Canada the possible volume of such work would be sufficient to justify real mass production methods, since these involve so considerable an outlay on factory plant and equipment. It is also a question whether houses can be designed which can be fabricated in this way and which will, at the same time, meet the natural desire of the owner or tenant for a cottage or dwelling which has an individuality of its own. Climatic difficulties in Canada must also be considered, and the increased expense which they entail.

In the United States, where the potential market is, of course, much larger than with us, attempts are being made to utilize the possibilities of fabricated construction in steel, precast concrete, timber, and plywood, and much ingenuity has been devoted to the design of inexpensive central units containing all the household equipment necessary for cooking, heating, bathing and laundry work, such a unit forming a kind of economic core around which the rest of the house can be assembled. Experience gained so far, however, indicates that these pre-fabricated houses are not yet so cheap as to be available for the lowest paid wage earner, partly because those now in the market include many labour saving devices and conveniences which are beyond the means of such families. Dealing with this subject at a recent convention, one speaker stated that the potential market for such houses in the United States must be mainly in the groups with incomes of from $1,500 to $3,000 per annum, in which there are some fourteen million families in the United States.

In Canada this phase of the subject is under consideration by the National Construction Council, and the Royal Architectural Institute of Canada has already appointed a special committee on low cost housing and slum clearance. The question of fabricated housing was brought up at a recent meeting of the Council of The Engineering Institute of Canada, and as a result of discussion it was suggested that a small committee be appointed, to study the possibilities of pre-fabrication and mass production, and work in collaboration with the architects' committee which is dealing with the question of low cost housing as a whole. This matter is now receiving attention. There is no doubt that if some satisfactory solution can be found for this problem under Canadian conditions, a very great advance will have been made in the provision of improved conditions of living for a large number of our citizens who have real need for assistance of this kind.

The Unwin Memorial

The long and active life of the late Dr. W. C. Unwin covered a period of remarkable growth in all branches of engineering, during which theory and experiment gradually gained recognition as bases for actual engineering work. In the nearly sixty years of his professional career he took a leading part in the development of the scientific training of engineers, and was as distinguished for his ability as a consultant on great engineering problems as for his services to engineering education.

With his death in 1933, in his ninety-fifth year, there passed away an engineer of international repute. He was the recipient of many honours. He was a Fellow of The Royal Society, and to him was awarded the first Kelvin Medal. He was President of The Institution of Civil Engineers in 1911, and President of The Institution of Mechanical Engineers in 1915 and 1916. The American Society of Civil Engineers and the American Society of Mechanical Engineers conferred their honorary memberships upon him. His well-known text books on machine design, first published in 1877 (of which 43,000 copies were sold), and on hydraulics (based on his classical article on that subject in the Encyclopedia Britannica), added greatly to his reputation. He was consulted in regard to many major engineering works, and was a recognized engineering authority on such widely diversified branches of engineering as hydraulics, steam power, the design of dams, transmission of energy, the strength and testing of materials, and machine design. He served with Lord Kelvin, Dr. Coleman Sellers and other eminent engineers on the International Niagara Commission, which was formed in 1890 to advise on the best method of developing and distributing Niagara Power. That Commission's decision to select electrical development by alternating current was followed by the adoption of this system in all parts of the world.

Of Dr. Unwin's relations with the many students who received their training from him it need only be said that he was their friend and guide, not only while at college, but throughout the whole of their professional careers. He was indeed an engineer and educationalist of international repute.

On Dr. Unwin's retirement from his professorship in 1904, his students established an Unwin Scholarship, which, however, was not a large one. As a fitting memorial to his life work it is now proposed to raise a sum of £2,500, a portion of this fund to be used to present to the Central Technical College a portrait or plaque of Dr. Unwin, the balance being applied to augment the scholarship in question to a value of at least £60 a year, so as to make it worthy of his name.

The matter is in the hands of an Unwin Memorial Committee, under the chairmanship of Sir Alfred Chatterton, C.I.E., F.C.G.I., K.I.H., and its membership includes many prominent British and American engineers. As Canadian representatives on this committee, Brig.-Gen. C. H. Mitchell, C.B., C.M.G., M.E.I.C., Dean of the Faculty of Applied Science, University of Toronto, Toronto, Dean Ernest Brown, M.Sc., M.Eng., M.E.I.C., Dean of the Faculty of Engineering, McGill University, Montreal, and Group-Captain E. W. Stedman, O.B.E., M.E.I.C., Chief Aeronautical Engineer, Department of National Defence, Ottawa, have been nominated.

A fitting memoir of Dr. Unwin, forming a permanent record of his life work, is being prepared by Mr. E. G. Walker, and will be issued at 10/6 per copy. Subscriptions for this volume, and contributions to the Memorial Fund, are requested from former students of the City and Guilds College, and from Canadian engineers, and they may be sent to the General Secretary of The Engineering Institute of Canada, 2050 Mansfield Street, Montreal.

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Tuesday, September 17th, 1935, at eight o'clock p.m., with President F. A. Gaby, M.E.I.C., in the chair, and seven other members of Council present.

The attention of Council was drawn to the fact that the present Canadian Standard Form of Construction Contract, issued by the Canadian Construction Association and approved by the R.A.I.C. and the E.I.C., while entirely suitable for building construction work, appears to require certain modifications to make it applicable to large engineering works. The following committee was appointed to draw up and recommend such modifications as may be thought desirable for this purpose:

R. E. C. Chadwick, M.E.I.C., *Chairman*
J. H. Brace, M.E.I.C.
C. S. L. Hertzberg, M.E.I.C.
J. A. McCrory, M.E.I.C.
J. W. Orrock, M.E.I.C.

It was noted with appreciation that, following a circular letter recently sent out, a considerable number of members on the non-active list have been able to rejoin the active list of The Institute.

The report of the Nominating Committee, containing that committee's list of nominees for officers for the year 1936, was received and examined by Council in accordance with the by-laws.

The Secretary presented a resolution passed by the Moncton Branch protesting against the inclusion in The Engineering Journal of articles in the French language, a copy of this resolution having been sent by the Moncton Branch to each of the other branches of The Institute. After discussion, Council decided not to recommend any change in policy in this matter.

Two resignations were accepted, two Life Memberships were granted, one hundred and forty-six members were replaced on the active list, and a number of special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

Elections		*Transfers*	
Members	3	Assoc. Member to Member	7
Assoc. Members	4	Junior to Member	1
Juniors	2	Junior to Assoc. Member	5
Students admitted	6	Student to Assoc. Member	2

The Council rose at eleven thirty p.m.

OBITUARIES

Frederick Passmore Gutelius, M.E.I.C.

Widespread regret will be felt at the death at North Bay, Ont., of Frederick Passmore Gutelius, M.E.I.C., on September 12th, 1935.

Mr. Gutelius was born at Mifflinburg, Penna., on December 21st, 1864, and graduated from Lafayette College in 1887 with the degree of C.E.

Early in his career he served the Pennsylvania lines as assistant engineer and supervisor for the region west of Pittsburgh, and from 1892 to 1894 Mr. Gutelius was in charge of a water power electric plant at Butte, Mont., later taking charge of the Butte City water works. Following this he was for a time engaged in general practice in Butte City. In 1895 Mr. Gutelius became general superintendent of the Columbia and Western Railway at Trail, B.C. He joined the staff of the Canadian Pacific Railway Company in 1898 and remained in the company's service, passing from one responsible office to another, and becoming general superintendent of the eastern division in 1912. He was occupying this position when the Dominion Government appointed him as a Royal Commissioner to enquire into the construction of the National Transcontinental line through northern Quebec and Ontario. Mr. Gutelius' ability was so highly appreciated by the government that he was chosen to be general manager of the Intercolonial and Prince Edward Island Railway, being located at

F. P. Gutelius, M.E.I.C.

Moncton, N.B. He was in charge of the government lines until 1917 when he became vice-president of the Delaware and Hudson Railroad Corporation in charge of operations and traffic. Since 1923 Mr. Gutelius has been resident vice-president of the Delaware and Hudson in Montreal.

Mr. Gutelius joined The Institute (then the Canadian Society of Civil Engineers) as a Member on December 18th, 1902.

Gustave Lindenthal, M.E.I.C.

It is with deep regret that we place on record the death on July 31st, 1935, of Gustav Lindenthal, M.E.I.C., at his home in Metuchen, N.J.

Mr. Lindenthal was born at Bruenn in Austria on May 21st, 1850, and received his school and technical education in that city.

In May 1874 he came to the United States as draughtsman and assistant engineer on the buildings for the Centennial Exhibition in Philadelphia, and in 1876 he located in

Cleveland, and until 1881 was bridge engineer of the old Atlantic-Great Western Railroad. Mr. Lindenthal subsequently settled in Pittsburgh, and was consulting engineer for a number of railroads, having designed and executed many large works, mostly bridges.

The works of Mr. Lindenthal were characterized by a daring in conception and execution and by a mingling of artistry with engineering technique which made him one of the outstanding bridge engineers in the United States. The spanning of Hell Gate is the accomplishment with which his name is perhaps most frequently linked. At the time of its completion in 1917, Hell Gate bridge was the largest arch bridge in the world, and both in design features and in construction methods it marked a great forward step in American engineering practice. Another of Mr. Lindenthal's designs which was notable for its æsthetic features was that for the Chesapeake and Ohio Northern Railroad crossing at Sciotoville, Ohio, a remarkable long span continuous-truss structure. Because of a combination of circumstances, the railroad suspension bridge across the Hudson river, designed by Mr. Lindenthal in 1888 for the North River Bridge Company, was never built. It was, however, a remarkably bold and well-conceived plan, calling for the first time for a single span across the river, 2,850 feet long and having a total length between anchorages of more than a mile.

Mr. Lindenthal was a prominent member of the American Society of Civil Engineers, having joined as a Member in 1882, and being elected to honorary membership in 1929. He received the Thomas Fitch Rowland Prize in 1883 for his paper entitled "Rebuilding the Monongahela Bridge at Pittsburgh, Pa.," and thirty-nine years later the same prize was awarded to him for his paper discussing the Sciotoville Bridge. In 1929 he was the first recipient of the Phebe Hobson Fowler Architectural Award. In 1920 Mr. Lindenthal received the degree of Doctor of Engineering from the Polytechnical School in Bruenn.

Mr. Lindenthal was a Fellow of the American Association for the Advancement of Science; a member of the (British) Institution of Civil Engineers and the Verein Deutscher Ingenieure; an honorary member of the Oesterreichischer Ingenieur und Architekten Verein and the Cleveland Engineers' Society.

Mr. Lindenthal joined The Institute (then the Canadian Society of Civil Engineers) on February 14th, 1889, and was made a life member on March 18th, 1932.

PERSONALS

A. E. Foreman, B.Sc., M.E.I.C., has been appointed associate professor of civil engineering by the University of British Columbia, Vancouver, B.C.

Mr. Foreman, who was born in 1878, had a brilliant career at McGill University, from which he graduated in 1903 with the degree of B.Sc., leading his class in each of four years and securing thirty-four first prizes, including the Scott Exhibition and Prize, Mathematical Exhibition and Prize, British Association Exhibition, Canadian General Electric Scholarship, and British Association Medal and Prize. He took an active part in athletics and was president of the McGill Basketball Club.

Following graduation Mr. Foreman spent three years in Toronto, securing business experience, and in 1907 went to Vancouver where he became secretary and manager of the Concrete Engineering and Construction Company. He was for one year, member of the firm of Dutcher and Foreman, consulting engineers, and was appointed supervising engineer for the city and provincial government on the Dallas Road Sea Wall, Victoria, B.C. In 1912, he was appointed assistant engineer of the city of Victoria, and in 1917, chief engineer of the Department of Public Works, which position he resigned in 1920 to become district engineer for the Portland Cement Association.

Mr. Foreman is a member of the Canadian Engineering Standards Association, the American Society for Testing Materials, and the British Columbia Good Roads League.

A. E. Foreman, M.E.I.C.

He is past-president of the Canadian Good Roads Association and the Association of Professional Engineers of British Columbia. He is chairman of the Road and Transit Committee of the Vancouver Town Planning Commission.

J. M. Paquet, S.E.I.C., is now sanitary engineer with the Provincial Board of Health, at Amos, Que. Mr. Paquet graduated from the Ecole Polytechnique in 1934 with the degree of B.A.Sc.

T. L. Hall, S.E.I.C., has joined the staff of the Canadian General Electric Company Limited, at Winnipeg, Man. Mr. Hall, who graduated from the University of New Brunswick in 1928 with the degree of B.Sc., has previously been connected with the same company.

F. Stewart Gumley, A.M.E.I.C., has been appointed designing engineer with Martin and Company at Calcutta, India. He will be in charge of design and construction of bridges, buildings and engineering structures in structural steel. Mr. Gumley, who was formerly works manager with J. and J. Lawrence Limited, in Edinburgh, Scotland, was at one time with the Western Bridge Company Limited, Vancouver, B.C.

J. M. Wardle, M.E.I.C., has been appointed Deputy Minister of the Department of the Interior, Ottawa, Ont.

Mr. Wardle was born at Chilliwack, B.C., and graduated from Queen's University with the degree of B.Sc. in 1912. Following graduation he was assistant to the city and municipal engineer of Chilliwack, and in 1914 he joined the Dominion Parks Branch of the Department of the Interior as assistant highway engineer. From 1915 until 1918 Mr. Wardle was acting chief highway engineer with the Dominion Parks Branch, and in 1918-1920 he was superintendent of the Banff National Park at Banff, Alta. In 1920 Mr. Wardle was appointed chief engineer of the Canadian National Parks Branch, Department of the Interior, Ottawa, which office he has held until the present time.

Charles C. Ross, M.E.I.C., Appointed Minister

The Hon. Charles C. Ross, M.E.I.C., has been appointed Minister of Lands and Mines in the new Alberta administration.

Mr. Ross was born at Ottawa, Ont., and graduated from McGill University in 1909 with the degree of B.Sc. (civil). Following graduation he was with the International Boundary Survey, and was subsequently with the

The Hon. Charles C. Ross, M.E.I.C.

Hydrographic Survey. From 1911 until 1913 Mr. Ross was in private practice, contracting. In 1916 he went to Calgary, and as senior mining inspector and later as supervisory engineer for the Department of the Interior he accomplished noteworthy results in the evolution and harmonious operation of the regulations for the development of the mineral resources of the prairie provinces. In 1928 Mr. Ross was appointed by the Minister of the Interior to set up departmental administrative machinery in northern Manitoba and northern Saskatchewan in connection with the mining development in those provinces, and since that time has supervised and administered all mining regulations affecting Crown lands in Manitoba, Saskatchewan, Alberta, the Railway Belt of British Columbia, the Yukon and the Northwest Territories. Mr. Ross later left the Government service and has been engaged in the development of oil and gas and mining as a consultant.

Mr. Ross is an active member of the Calgary Branch of The Institute.

The following members of The Institute have been appointed by the Executive Committee of the City of Montreal to investigate the waterworks intake at Ville LaSalle, and to report to the administration what amount of money is necessary to equip the aqueduct properly in this connection: R. de L. French, M.E.I.C., Professor of Highway and Municipal Engineering, McGill University, and consulting engineer, A. Plamondon, A.M.E.I.C., consulting engineer, Montreal, J. M. Robertson, M.E.I.C., consulting engineer, Montreal, E. Gohier, M.E.I.C., consulting engineer, Montreal, J. E. Blanchard, M.E.I.C., Director of Public Works, Montreal. C. J. Desbaillets, M.E.I.C., chief engineer of the Montreal Water Board will act as secretary.

Lieut.-Colonel L. N. Seaman, M.E.I.C., received the Order of the British Empire in the King's Birthday Honours List this year, and was invested with the decoration at Buckingham Palace by His Majesty the King on July 10th last. Colonel Seaman was formerly Officer in charge of Timber Testing with the Forest Research Institute, Dehra Dun, India, but has now retired. He is at present visiting Canada, and is staying at Halifax, N.S.

George E. Kent, A.M.E.I.C., has joined the staff of the International Petroleum Company at Talara, Peru, as assistant superintendent. Mr. Kent graduated from the Nova Scotia Technical College in 1928 with the degree of B.Sc., and following graduation was, until 1929, with the Bell Telephone Company of Canada at Montreal. In September 1929 he joined the staff of the Imperial Oil Refineries Limited at Sarnia, being in the draughting department on the design of oil refinery equipment. In 1930 Mr. Kent became assistant mechanical superintendent with the same company, and in 1932 he was assistant to the refinery superintendent.

Elections and Transfers

At the meeting of Council held on September 17th, 1935, the following elections and transfers were effected:

Members

BAKER, James Davidson, Deputy Minister and General Manager, Alberta Government Telephones, Edmonton, Alta.

CALDER, William, 10122-123rd Street, Edmonton, Alta.

FINDLATER, Richard Hamilton, F.I.C., M.Inst.P.T., 74 Highfield St., Moncton, N.B.

Associate Members

DOUGLAS, John Holden Webb, mech'l. supt., Dept. of Public Works Alberta, Edmonton, Alta.

EVANS, Thomas Owen, B.Sc., (McGill Univ.), asst. supt., Back River Plant, Montreal Island Power Co., St. Vincent de Paul, Que.

HARDY, William Gathorne, B.Sc., (N.S. Tech. Coll.), 4879 Patricia Ave., Montreal, Que.

HERR, Arthur George, chief dftsman., Packard Electric Co. Ltd., St. Catharines, Ont.

Juniors

FORTIN, Jean Julien, B.Sc., (Queen's Univ.), tracer and designer, Duke-Price Power Co., Arvida, Que.

*KING, Eric Charles, power house operator, Churchill River Power Co. Ltd., Island Falls, Sask.

Transferred from the class of Associate Member to that of Member

BUCHAN, Percy Halcro, B.A.Sc., (Univ. of Toronto), asst. engr., mtce. of way, B.C. Electric Rly. Co. Ltd., Vancouver, B.C.

DORMER, William John Smylie, B.Sc., (McGill Univ.), district engr., (Montreal Suburban and Three Rivers Districts), Bell Telephone Company of Canada, Montreal, Que.

GILBERT, Gordon Macdonald, B.Sc., (Univ. of Man.), supt. and acting-engr., Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver, B.C.

ROBERTSON, James, B.Sc., (McGill Univ.), engr. Pacific Divn., Dominion Bridge Co. Ltd., Vancouver, B.C.

STUART, Harold Brownlee, B.A.Sc., (Univ. of Toronto), field engr., Hamilton Bridge Co. Ltd., Hamilton, Ont.

THRUPP, Edgar Charles, (Kings College, London, England), 2626-13th Ave. West, Vancouver, B.C.

WHEATLEY, Edward Augustus, M.C. and Bar, (City and Guilds Tech. Coll.), registrar and sec.-treas., Association of Professional Engineers of the Province of British Columbia, Vancouver, B.C.

Transferred from the class of Junior to that of Member

MacNICOL, Nicol, B.A.Sc., (Univ. of Toronto), works commissioner, Forest Hill Village, Ont.

Transferred from the class of Junior to that of Associate Member

FOX, John H., B.A.Sc., (Univ. of Toronto), engr., Minneapolis-Honeywell Regulator Co. Ltd., Toronto, Ont.

LEA, Harry Windsor, B.Sc., (McGill Univ.), designing engr., Montreal Sewers Commission, 1226 University St., Montreal, Que.

McGILLIS, Lester, B.Sc., (McGill Univ.), manager, Beauharnois Divn., Shawinigan Water and Power Co., Valleyfield, Que.

THOMPSON, William Lennox, B.A.Sc., (Univ. of Toronto), sales service engr., Bailey Meter Co. Ltd., Montreal, Que.

*VARLEY, Percy, elect'l. dftsman., Canadian Industries Ltd., Montreal, Que.

Transferred from the class of Student to that of Associate Member

BOSTOCK, William Norman, Capt., R.C.E., B.Sc., (McGill Univ.), (Grad., R.M.C.), Work Point Barracks, Esquimalt, B.C.

MULLIGAN, Henry Ineson, B.Sc., (McGill Univ.), N.B. Electric Power Commission, Newcastle Creek, N.B.

Students Admitted

ALLEN, Richard T. W., B.Sc., (Univ. of Alta.), P.O. Box 891, Vernon, B.C.

DAVEY, Roland Eric, B.A.Sc., (Univ. of Toronto), Dufferin Paving Co. Ltd., Kenora, Ont.

GRIFFITHS, George Henry Rickard, B.Sc., (Univ. of Man.), 212 Forest Ave., West Kildonan, Man.

MILLER, Donald Waters, B.Sc., (Univ. of Man.), 616 Ashburn St., Winnipeg, Man.

WELSH, James Gordon, (Univ. of Toronto), 1078 Valley Way, Niagara Falls, Ont.

WILLIAMS, Stanley Chevers, B.Sc., (Queen's Univ.), 23 Ossington Ave., Ottawa, Ont.

*Has passed Institute's examinations.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Civil Engineers: Proceedings, volume 238, 1933-1934.
New Zealand Society of Civil Engineers: Proceedings 1934-35.
Canadian Electrical Association: Proceedings of the 45th Annual Convention, 1935.

Reports, etc.

Institution of Civil Engineers: List of Members 1935.
Canada Bureau of Statistics: The Canada Year Book 1934-1935.
National Research Laboratories: Report No. P.A.A. 22—"The Aerodynamic Characteristics of Aircraft Skis and the Development of an Improved Design" by J. J. Green and G. J. Klein.
International Tin Research and Development Council:
Technical Publications Series A—No. 19—"The Use of Sodium Sulphite as an Addition to Alkaline Detergents for Tinned Ware."; No. 20—"The Twinning of Single Crystals of Tin." Series B—No. 2—"Equilibrium Diagrams of Binary Alloys of Tin." Series D—No. 2—"Black Spots on Tin and Tinned Ware."
Metropolitan Life Insurance Company: "How Equipment Manufacturers Provide against Inadequate Specifications in Customers' Orders."
Ontario, Department of Mines: Bulletin 100 "Mineral Production of Ontario, First Six Months of 1935."
Ontario, Department of Mines: Bulletin 99 "Mines and Metallurgical Works of Ontario in 1934."
Queen's University: Calendar of the Faculty of Applied Science 1935-1936.
University of Toronto: Faculty of Applied Science and Engineering: Bulletin No. 148 "Horizontal Thrusts for Two-Hinged Arches of Various Forms" by C. R. Young and M. W. Huggins.
Canada, Dept. of Mines, Mines Branch: "A Study of Clay Winning and its Costs in the Provinces of Ontario and Quebec" by J. F. McMahon.
Canada, Dept. of Mines, Mines Branch: Investigations in Ore Dressing and Metallurgy—January to June 1934.

Technical Books, etc., Received

Mechanical and Electrical Equipment for Buildings, by C. M. Gay and C. de Van Fawcett. (*John Wiley and Sons, New York.*)
Elementary Structural Problems in Steel and Timber, by C. R. Young. (*John Wiley and Sons, New York.*)

BOOK REVIEWS

Working, Heat Treating and Welding of Steel

By H. L. Campbell, John Wiley and Sons, New York. 1935. 6 by 9¼ inches. Photos. Diagrams. 185 pages. Cloth. $2.25.

Contents: Manufacture of iron and steel; composition; classifications; testing; effects of heat treatment and mechanical working; processes and equipment for working; constitution of steel (metallography); processes and equipment for heat treatment; alloy steels; processes and equipment for welding; surface preservation; laboratory experiments (eighteen).

The author's aim has been to present in a concise way the principles and practice relative to the working, heat treating and welding of steel.

All this subject matter, leading up to the experiments, is covered in 148 pages, and it is obvious that the treatment cannot be detailed; however the style is concise and clear, and the halftones and diagrams are, respectively, well chosen and well drawn; there are very few errors.

The book is essentially designed as a laboratory manual for second or third year students in mechanical engineering. It should not, of course, be compared with any of the standard text- and hand-books covering the many phases referred to; but, in addition to its main purpose, it would well serve as an introduction to stimulate interest in the subject on the part of those unfamiliar with the metallurgy of steel. A well-selected list of reference books is included.

The Principles of Electric Power Transmission

By H. Waddicor. John Wiley and Sons Inc., New York. 1935. 5½ by 8¾ inches. Diagrams. 449 pages. Cloth. $6.00. (Renouf Publishing Company, Montreal.)

Reviewed by Edgar T. J. Brandon, A.M.E.I.C.*

In the third edition of this useful book, the author has attempted to bring up to date such parts of it as required revision.

The book is useful in that it brings together in one volume features of electric power transmission heretofore treated separately. As a result, some of the chapters, such as those on "Line Conductors and Supporting Structures" and "Apparatus for the Prevention of Dangerous Currents" are very elementary and cannot be considered as other than presenting a very general outline of the subject matter with which they are dealing.

The book is notable for the originality of treatment of some phases of the subject, and also for the freedom with which the author has given the source of other data.

Chapter XI on "Economic Principles and Calculations" emphasizes the fundamental laws, but makes only very general statements regarding economic principles.

There are some examples of lack of balance in the treatment of various subjects. For example, distance protection is covered in one page, whereas spark gaps of various kinds are given nine pages.

Chapter XIII on "Pressure Rises" deals very clearly with the theory of travelling waves, and the transient voltages appearing on transmission systems. This chapter is of considerable value in a book on power transmission.

Chapter XV on "Power Limits of Transmission Systems" deals with the subject mathematically and may give the wrong impression of this problem to a casual reader. The author is careful to point out, however, that practical considerations modify calculations of power limits to a great degree.

A very valuable bibliography is found at the end of each chapter, and the author is to be commended for including this. He has evidently studied American as well as European practice, so that the book has merit in that it expresses the author's opinion of the best in each, and as such, is of more than ordinary interest to the American engineer.

Chief electrical engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ont.

Mechanical and Electrical Equipment for Buildings

By C. M. Gay and C. De Van Fawcett. John Wiley and Sons, New York. (Renouf Publishing Company, Montreal) 1935. 6 by 9¼ inches. Diagrams, tables. 429 pages. Cloth. $5.00.

Reviewed by E. A. Ryan, M.E.I.C.*

This new work on the subject of mechanical and electrical equipment for buildings is a very complete review of the major problems to be solved in the equipment of a modern building. The authors have purposely prepared the work for members of their own profession, the architects, and with this in mind they refrained from presenting a treatise that is technical in the extreme. They have preferred rather to treat the various subjects in the simplest possible forms but have, nevertheless, given the fundamental technical data governing the solution.

The work treats of water supply, plumbing, drainage, heating, air conditioning, electrical equipment and acoustics, and gives very valuable information on the better known systems and apparatus commercially available.

Chapters are included on water supply equipment and the design and installation of water supply; plumbing fixtures and private sewage disposal; warm air, steam and hot water heating; electrical materials and machinery, wiring systems; elevators, and interior and flood lighting.

It should prove very convenient and useful to all practising architects, or even engineers whose duties do not require a deep knowledge of any of the foregoing branches but who at the same time should have a working knowledge of the underlying principles and facts.

Consulting engineer, 1188 Phillips Place, Montreal.

ANNUAL MEETING 1936

The Fiftieth Annual General and General Professional Meeting of The Institute is to be held at The Royal Connaught Hotel, Hamilton, Ontario on Thursday and Friday, February 6th and 7th, 1936.

BULLETINS

Signal Systems—A 4-page leaflet received from Edwards and Company of Canada, Montreal, gives particulars regarding a number of the company's signals and alarm systems.

Motor Trucks—The Four Wheel Drive Auto Company, Clintonville, Wis., have issued a 12-page bulletin detailing features and uses of their Model HS for high speed hauling.

Graders—A 40-page booklet issued by the Caterpillar Tractor Company, Peoria, Ill., describes their elevating graders Nos. 42 and 48 which are available in either engine-driven or power take-off designs. The first, with a 42-inch carrier belt, requires a 40-h.p. engine; the latter size, with 48-inch carrier belt, requires a 46-h.p. engine. Both sizes can be obtained with carriers of from 14 to 25 feet.

Compressors—A 4-page leaflet received from the Worthington Pump and Machinery Corporation, Harrison, N.J., contains data on the company's steam booster compressors.

Pumps—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued a 4-page folder describing and illustrating their deep well turbine pumps, types Q and QA, obtainable for installations requiring from 30 to 225 U.S. gallons per minute at heads up to 400 feet.

Aerial Ropeways—A 48-page booklet received from Ropeways Limited, London, England, illustrates types and systems of aerial ropeways, and their general uses and advantages.

List of New and Revised British Standard Specifications

(issued during June and July, 1935).

B.S.S. No.

613—1935. *Components for Radio-Interference Suppression Devices.*
First of a series of specifications dealing with radio interference. Originated in a sub-committee of the I.E.E. Deals with rating, performance, and tests of condensers, inductors and resistors used in the construction of interference suppressors. Appendix gives diagrams of connections and schedules of component values.

618—1935. *Emulsions of Road Tar and of Road Tar-Asphaltic Bitumen Mixtures for Penetration (Grouting and Semi-Grouting) and Surface Dressing.*
First B.S. Specification for a cold road dressing, incorporating tar. Appendices are included giving methods of sampling and testing of the emulsion.

620—1935. *The Dimensions of Grinding Wheels and Method of Attachment.*
Dimensions of generally used shapes and sizes of grinding wheels, and of the flanges and washer plates to be used with the standard method of attachment. Tolerances and fits of the spindle in the wheels are specified, with the quality of the material from which the spindle and flanges are to be made.

621—1935. *Wire Ropes of Special Construction for Engineering Purposes, inclusive of Cranes, Lifts and Excavators.*
Providing for Seale construction, oval and flattened strand and multiple strand wire ropes from 1½ to 6 inches circumference for special engineering purposes including cranes, lifts and excavators.

Copies of these specifications may be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, England and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

The Institution of Civil Engineers of Ireland Celebrates its Centenary 1835-1935

(*Contributed by N. F. Harrison, A.M.E.I.C.*)

On August 6th of this year, The Institution of Civil Engineers of Ireland celebrated its one hundredth birthday. It was on August 6th, 1835, that a few Irish engineers, animated by the need of a national organization for the engineering profession in Ireland, first met under the chairmanship of Colonel John Fox Burgoyne in the old office of Public Works, Dublin, for the purpose of forming an association to be called "The Civil Engineers Society of Ireland."

In its early years the society encountered many difficulties, but a successful reorganization was effected in 1844, and its title changed to its present form.

The first printed transactions appeared in 1845, the opening paper being one read on November 12th, 1844, by Robert Mallet, F.R.S. (President 1865-67), on "The Artificial Preparation of Turf (Peat) Independently of Season or Weather."

In 1877 a Royal Charter was granted to the Institution by Queen Victoria, and it will be of interest to many Canadian engineers to know that in the charter year, Robert Manning (whose celebrated paper on "The Flow of Water in Open Channels and Pipes" was read to the Institution of C.E.I. on December 4th, 1889) was President.

Two days were given over to the centenary celebrations this year. On August 6th a special meeting was convened at the Engineers' Hall, Dublin, when an address appropriate to the occasion was delivered by the President (Mr. Nicholas O'Dwyer) and delegates, bringing felicitations from the universities and various sister institutions and associations, were received. In the evening a reception and dance was held in the Mansion House.

On August 7th visits were paid to the new stand-by plant of the Electricity Supply Board at the Pigeon House Fort, the Main Drainage Outfall Works of the Dublin Corporation, and an inspection trip, by steamer, of the Port of Dublin.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

There were about thirty persons present at the meeting which was held after dinner at the Prince Edward hotel, on Friday, May 17th, 1935. Owing to the continued illness of our secretary, the minutes were not read. B. Candlish, A.M.E.I.C., spoke of a proposed visit to Sarnia and a vote was taken to see how many were interested. Everyone appeared to be in favour of the idea.

F. H. Kester, M.E.I.C., introduced P. L. Pratley, M.E.I.C., of the firm of Monsarrat and Pratley, Montreal, which is very well known for its work throughout the Dominion. The subject of the paper presented was "The Isle of Orleans Bridge." The construction of this bridge was part of the government's plan to aid the unemployed.

The Isle of Orleans Bridge

The major problems in design were (1) to have as large a Canadian content as possible; (2) to overcome political opposition and restrictions. These two problems were overcome by the firm submitting two recommended designs. One which could be constructed under the restrictions and specifications cited; the other was the best design for the conditions existing at the site of the proposed bridge. The latter, a suspension bridge combined with truss spans, was finally chosen.

A good deal of attention was paid to the æsthetics of the design as well as the technical details so that the structure would not mar the landscape.

Mr. Pratley discussed the general details covering substructure and superstructure which have been previously reported upon in The Journal. One of the new innovations on this particular project was the use of the "Truscon Tee Grid" flooring system which lightened the load due to floor stem and also enabled the contractor to use the bridge floor prior to the pouring of concrete.

After a good deal of interesting discussion, it was moved by R. A. Spencer, M.E.I.C., that a hearty vote of thanks be extended to Mr. Pratley, which was seconded by H. J. Coulter, A.M.E.I.C.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Through the courtesy of the Cunard White Star and Donaldson Atlantic Lines, members of the Montreal Branch of The Institute with their ladies and friends visited the *Ascania* and *Athenia* on Wednesday, September 18th, 1935.

Luncheon was served on board the *Ascania* at 1 o'clock p.m., some one hundred and fifty being present. F. S. B. Heward, A.M.E.I.C., chairman of the Branch, presided and thanked the officials of the Cunard White Star Line for their kindness in arranging for the visit. Eric Reford, of the Robert Reford Company Limited, welcomed the visitors on behalf of the owners of the *Ascania*. Chief Officer H. N. McGill also spoke a few words of welcome. Dr. F. A. Gaby, M.E.I.C., President of The Institute, was among those at the head table.

Both ships were open for inspection from 12.30 to 3.00 o'clock p.m. and a large party took advantage of the opportunity of viewing them, the boiler and engine rooms of the *Ascania* proving of particular interest.

The English Electric Company of Canada, Limited, announces the formation of a new Lighting Division, which will manufacture and sell "Barlux" tubular lamps and fittings. These lamps are of 3-ply opal glass in lengths from 6 inches to 48 inches, bent to any desired curve. The standard sizes are 38 mm. and 40 mm. diameter and consume 35 and 60 watts per foot respectively.

The International Nickel Company of Canada Limited have announced their intention of erecting a chemical and research laboratory at Copper Cliff, Ontario. This will deal with projects leading to improvements in the process for refining nickel and copper, with particular emphasis directed towards the development of new uses for copper.

River Improvement Work in Manchuria

A description of the Training and Protective Work Carried out on the Lower Liao River

E. E. Lord, A.M.E.I.C.,
Estimator, Smith Bros. and Wilson Limited, Regina, Sask.
Formerly Assistant Engineer, Lower Liao River Conservancy, Newchwang, Manchuria.

Paper presented before the Saskatchewan Branch of The Engineering Institute of Canada, March 22nd, 1935.

Manchuria has a climate somewhat similar to that in Regina, the temperature ranging from a maximum of about 98 in summer to 15 below zero in the winter. However, there is a great deal more wind and much of the work seemed to be a continual fight against wind. The yearly rainfall averages about 23 inches but nearly half occurs in a period of about three weeks during July and August. The total drainage area of the Liao river is 80,000 square miles and the greater part is entirely barren of trees with a rather loose sandy soil which is subject to erosion. This meant that the Liao river at some periods of the year carried a tremendous amount of silt.

The Port of Newchwang is situated about 11 miles from the mouth of the river, at which point the river is approximately 2,000 feet wide and 35 feet deep at low water. During the cold weather the river at Newchwang froze over in November and opened some time in March, the port usually being closed for about four and a half months. The main export from Newchwang was soya beans or soya bean oil and at one time it was a thriving port with some 20,000 junks sailing up and down the Liao river. Soya beans were brought from the interior and general cargo and salt, extracted from sea water at Newchwang, carried back. These junks were taxed on the trip down and also on the trip up at a town called Tien Chwang Tai, some 15 miles up river from Newchwang.

There is a branch of the river running from Tan Chia Wo Pu to the sea north of Newchwang (see Fig. 1) this is the Shwang Tai Tzu branch. Originally this was not a branch at all but was a creek which had its source near the Liao at Tan Chia Wo Pu and ran from there to the sea. There was no connection between this creek and the Liao river. However, some junk owners conceived the idea of digging a small canal to connect this creek with the Liao river as they could then go down the canal and the creek to Newchwang and dodge the tax collectors at Tien Chwang Tai. They dug the canal, and as it was only eight feet wide and would only take a small boat, no one worried about it. The distance to the sea via the Shwang Tai Tzu branch is much shorter than via the Liao river and in consequence the water tended to go that way. This tendency gradually scoured out the creek until now it is a large river and robs the Liao of anywhere from 15,000 to 40,000 second-feet of water.

The tidal limit of the Liao river does not reach the point where the Shwang Tai Tzu branch leaves the main river and all the water going down the branch is fresh water. A silt analysis of the water taken at various points on the river shows that the water coming down the main river and in the Shwang Tai Tzu branch is reasonably clean and that most of the silt and sand comes in from the two branches which join further down the Liao river. This silt and sand is gradually carried down river by the ebb tide and the fresh water discharge until it reaches the mouth of the river. There was then no training wall at the mouth of the river and the ebb with its heavy silt content deposited silt and sand to form a bar. There had always been a bar at the mouth of the Liao river with approximately 9 feet of water over it at low water but there was a sufficient fresh water discharge at all times to maintain that depth. However, when the Shwang Tai Tzu branch started robbing the Liao of its fresh water the bar began to silt up and finally in 1914 it had silted up until there was only 6 feet of water at low water.

The tide rises from 10 to 14 feet at the bar, and this added to the original 9 feet of water gave a high water depth of 19 to 23 feet which was generally sufficient for the China coastal steamers, but when the bar had silted up 3 feet steamers had to go out with three feet less draught which meant a loss of considerable cargo. As a result most steamers had to go to another port to fill up. The nearest port was Dairen where there was plenty of water and an excellent harbour and many ships were going there and not calling at Newchwang at all. The upper reaches of the river below the Shwang Tai Tzu branch were also silting up and junks had difficulty in getting down river to Newchwang. In fact, something had to be done.

The Liao River Conservancy Board was formed in 1914 and was composed of various Chinese officials and the managers of shipping companies and any foreign consuls located in Newchwang. A tax was placed on shipping to obtain funds and Mr. Hughes was appointed engineer for the board and Sir John Wolfe Barry & Lister consulting engineers. Mr. Hughes was also carrying out considerable work in other parts of Manchuria for the Chinese government and could not devote all his time to the Conservancy work.

The obvious thing to do to improve the river was to close the Shwang Tai Tzu branch and this was tried on two occasions. However, towns had grown up along the branch and there was considerable traffic on the river, also customs stations had been established to tax the junks. When work was started on the closure there was a great deal of complaint and finally the works were torn out and a few riots staged so that the closing had to be abandoned. The consulting engineers then recommended the dredging of the upper reaches of the river which were silting up, the construction of two training walls at the mouth of the river and the closing of the west channel near the mouth of the river. (See Fig. 2.) The training walls at the mouth of the river were to confine the ebb tide across the bar and thereby scour out a channel over the bar. As the set of the tide on the bar was in a southerly direction the east training wall was essential, but both would be better, if finances permitted.

Mr. Hughes, the engineer for the Board, made surveys of the river and in the years 1916, 1917 and 1918 closed the west channel and started the east training wall at No. 5 beacon and carried it out to Mound Beacon. He died in 1918 and in 1919 Mr. P. N. Fawcett was appointed engineer-in-chief of the Lower Liao River Conservancy and the author was appointed assistant engineer early in 1920. Figure 3 shows the part of the river with which our work was concerned, that is from the entrance up to Swan island, and this article will deal with that section.

The Survey Work

The only way to watch the various changes in a river is by taking frequent soundings if possible in the same places each year. It was decided to do this and permanent sounding lines were established across the river at about 1,000 feet apart. Concrete posts 4 by 6 inches and 4 feet long were placed in the ground on the sounding line, one on either bank of the river, and in all 117 lines were marked in this way from Signal Station to Swan island. These sounding line stones were also used as bench marks and triangulation points.

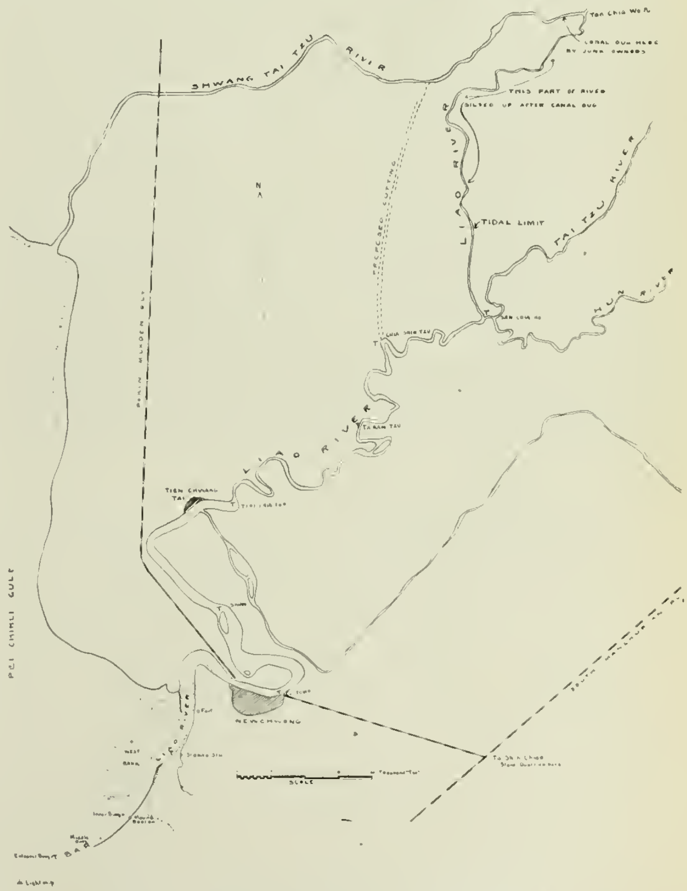

Fig. 1—The Liao River and Tributaries.

The next step was to make a proper triangulation of the whole river from the bar to Swan island. (Fig. 3.) Sides of the triangles were from one to three miles long. Accurate base line measurements had already been made by Mr. Hughes from Fort to Signal Station. All angles were measured six times by trebling the angle then reversing the instrument and again trebling it. The correction of the survey was interesting as all triangles were corrected to 180 degrees and the central angles of each polygon corrected to 360 degrees, also in each polygon the sum of the log sines of right hand external angles was corrected to equal the sum of the log sines of the left hand external angles. With so many triangles being common to two polygons this last correction was complicated but the results were gratifying indeed. When taking angles minor triangulation was made of any prominent chimneys, flagstaffs, etc., which might be useful for sounding work. The angles at East Bank Beacon and West Bank Beacon on the bar were taken with sextants, as these were in about 10 feet of water.

In plotting the surveys and for taking and plotting soundings three draughting boards 4 by 6 feet were used. All points of the triangulation were plotted on these boards, one for work on the bar and two for the river. The banks of the river were then fixed by walking along the bank with a sextant and every two or three hundred feet taking two angles on any three triangulation points.

The next step was to obtain levels, as no levelling had been done along the river. These were started from Signal Station and ran to Swan island with bench marks established where a tide gauge might be placed. It was also necessary to have a level close to the bar for sounding the bar, and as the east training wall had been built from No. 5 Beacon to Mound it was decided to run levels down to Mound. The training wall was only built to a height of about two feet above low water, so concrete blocks 4 by 6 feet and 4 feet high were first poured on the wall and a hole left in the centre to take a beacon, which served to mark the wall when it was covered at high water. The training wall was constructed of hand size rubble stone and was settling slightly all the time so that levels were carried out from Signal Station to Mound every year before any sounding on the bar took place.

The levelling completed, tide gauges were established at seven points along the river. The gauges used were 2- by 8-inch plank nailed to a pile driven in the sand. They were 20 feet and the pile 25 feet long. Owing to shortage of funds a floating pile driver was not available so that all piles were driven by hand. The method was briefly: two junks were taken out on to the bar with their crew of seven men each and about six extra coolies to assist. These junks, about 40 feet long with a 9-foot beam, were anchored fore and aft at the spot where the gauge was to be placed with a foot of clearance between the junks. Two poles 10 feet long were lashed to the pile one on either side at a suitable height and the pile then hoisted to an upright position over the water with the poles forming a large T. Ten men would then scramble up on to the tee pieces and when all set the pile would be let go. The weight of the pile and men on it was sufficient to drive it into the sand enough to make it stick; then four guys were made fast to the top and the driving action would start. This was accomplished by swaying the pile from side to side by the guy ropes and at the same time the ten men on the tee piece would jump up and down, the men all jumping in unison with a song accompaniment and a huge amount of shouting by the remainder of the crew, the foreman shouting the loudest of all. It was a most bizarre method of driving piles but it worked. Large beacons 60 feet in height with a 17-foot diamond on the top were driven in the same way to a depth of ten or twelve feet in hard sand, the only difference being that there were more men, more singing and more shouting. This method was only used where piles or beacons were driven in water. Later a small hand power jetting pump was added to the equipment.

Having erected the tide gauges at the middle and outer buoys it was necessary to obtain their levels. These gauges were in the open sea, the latter being five miles out from Mound Beacon and the only way to obtain their levels was to obtain high water reading, which is always a level plane or nearly so, of the gauges at Mound Beacon Signal Station and the two buoy gauges. The only trouble was that there always seemed to be a wind or a bad sea to contend with and junks anchored at the buoys with tide gauge readers on board would run for shelter when a sea came up, and if the wind died down the junks could not get out to the gauges again against the tide. Finally, after about two weeks' trial, the necessary readings were obtained. These readings coupled with those at the other two gauges gave figures from which the slope of the water on both flood and ebb tides could be plotted. All was now ready to take soundings on the bar, when the gauges at the middle and outer buoy were stolen during the night.

The erection and levelling of the gauges had cost considerable money and it was decided that it was not worth the expense, as when readings of the tides taken at these four gauges were plotted they showed that, for sounding purposes, the gauge at Mound Beacon could be used on most of the ebb tide and obtain from it reductions which would be sufficiently accurate for the whole bar.

When gauges were established and levelled at the other points on the river previously mentioned it was decided to take a series of simultaneous tidal observations on the whole river. The Upper River Conservancy staff established gauges on their section and simultaneous readings were taken every ten minutes over the whole of the tidal part of the river. The tide gauge readers were usually slightly educated coolies who were supplied with watches. These coolies were anxious to see how the watches worked, much to the detriment of the watches, and one could never be sure for any length of time that all watches were going and correct. When the watches stopped the obliging coolies would guess at the time for possibly a twelve hour stretch and it was also found that the readers would go to sleep for two or three hours and then guess at the height of the tide for that period. After a good deal of disciplinary action and patience excellent results were finally obtained and these were of value as they showed the progress of the tidal wave up river and gave the quantity of the tidal charge of the river.

Taking Soundings

The all important work of the survey department and the most interesting was taking soundings. One complete survey was made of the whole bar every year and usually one or two smaller surveys of those parts on which work was to be done. Also one complete survey was made of the river from Mound Beacon up to Swan island. The scouring effect of the training wall on the bar was of interest and the only way to watch it was by taking soundings. Each spring three large survey beacons were placed on the bar at Mound, East Bank and West Bank, the remaining beacons shown on Fig. 2 were placed by the customs service as aids to navigation but were useful as well. Those beacons placed on the training wall were in concrete blocks and did not need to be triangulated but the remainder had to be triangulated as soon as erected in the spring.

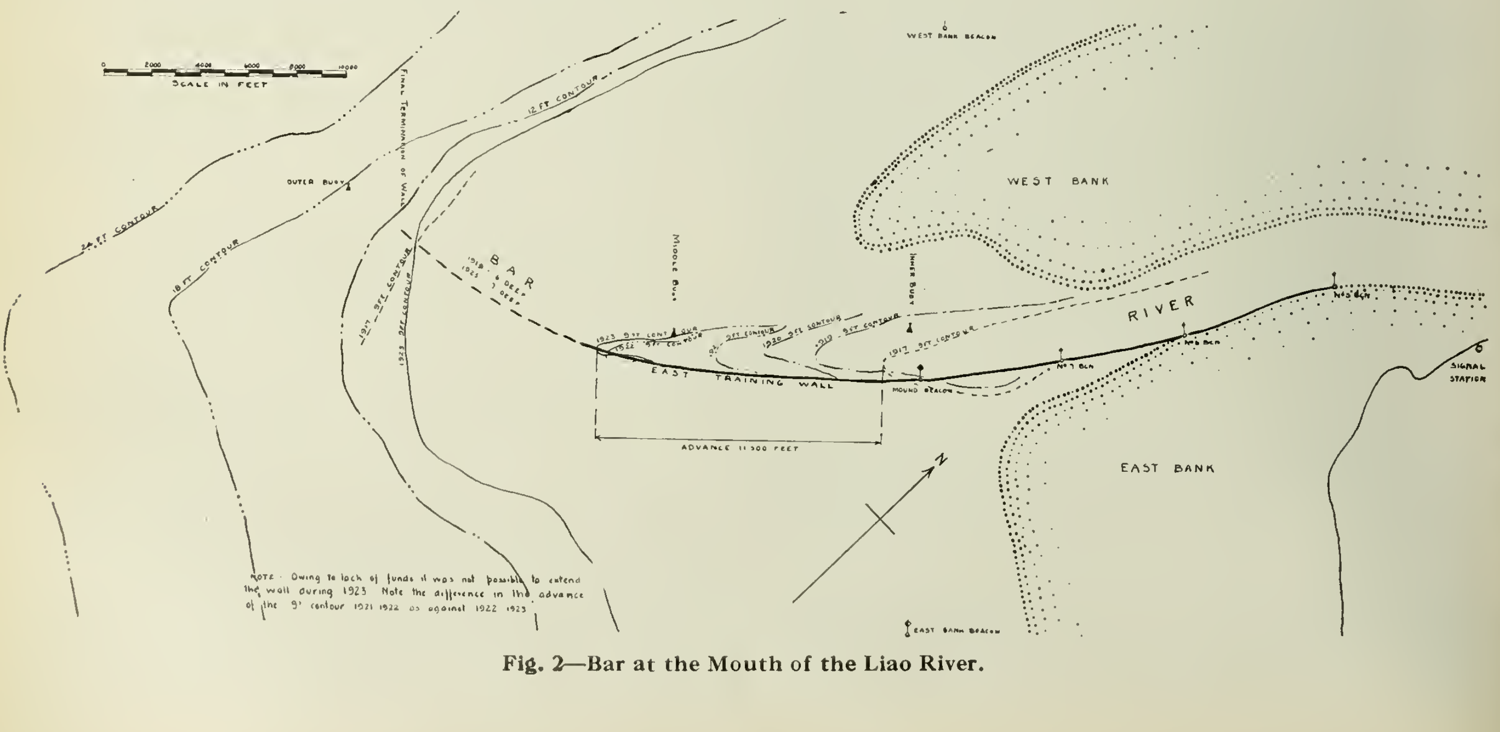

Fig. 2—Bar at the Mouth of the Liao River.

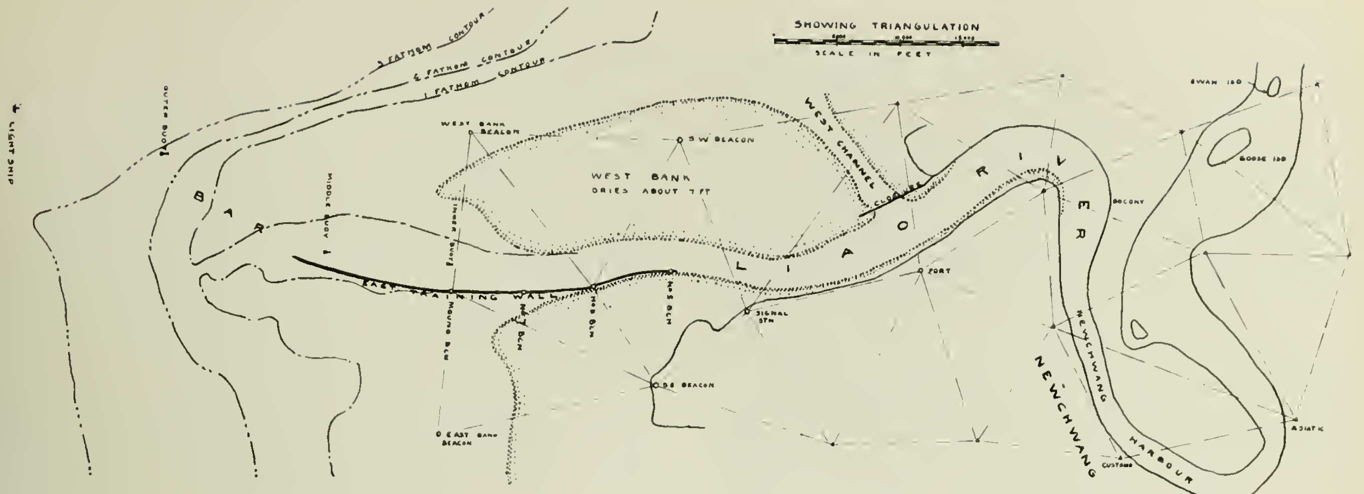

Fig. 3—Triangulation of the Lower Liao River.

For sounding on the bar a 60-foot steam launch with a crew of six men was used. Before starting the survey a series of transit lines that the launch could steam along were laid out and it was arranged so that no two sounding lines were over 1,000 feet apart. All depths were read to 3 inches using bamboo poles for depths up to 16 feet and lead lines for over that depth. Tide gauge readers were placed at Signal Station and Mound Beacon with watches corrected. When sounding the launch ran at a speed of 3 to 4 knots, two sailors, one on either side of the launch, took the depth taking about ten soundings a minute all of which were recorded in the sounding book. The author and his assistant would fix the position of the launch by taking sextant angles on three beacons at the same time. That is, the angle between East Bank Beacon and Mound would be measured and also the angle between Mound and West Bank Beacon. The position of the launch was fixed about once a minute during which time ten soundings had been taken and the launch travelled 400 feet. The time of fix and angles were all entered in the sounding book. A survey of the bar usually took about two weeks. It could have been done quicker but when sounding to 3 inches the sea must be calm and it was sometimes necessary to wait for days before anything could be done.

As the nearest tide gauge to the bar was at Mound Beacon it was necessary to stop sounding as soon as there was a suspicion of flood tide at the outer buoy. All soundings were reduced to the depth at low water of ordinary spring tides which meant that the depth at any one place was reduced by the amount that the gauge at Mound showed above low water, but if there was a slight rise in the tide at the outer buoy it meant that the slope of the water over the bar was in the form of a very flat V with the bottom point of the V gradually coming nearer Mound Beacon until such time as the flood tide started making at Mound. If sounding at that time readings on the gauge at Mound showed low water with no reduction in the soundings whereas actually at the outer buoy the tide may have risen as much as 9 inches and depths would show that much greater than they actually were. On some tides the water would actually rise a matter of 6 inches in ten minutes. No soundings were taken on the flood tide except in places where accuracy was not important.

River sounding was quite different in some respects. A gauge could be driven down in the soft mud quickly at any place where there was a bench mark and thereby sound at any state of the tide and also in most places there was no sea and soundings were only taken to 1 foot. The same launch was used but always with a lead line as the depth ranged anywhere up to 40 or 50 feet. Two men were placed on each bank of the river, each man with a light beacon 15 feet high. A man on either bank would place his beacon on the sounding line stone and his mate would place the other one in line with the stone and the beacon across the river. This gave the launch two beacons on either bank to keep in line. Large flags were also placed at all triangulation points on either bank in the vicinity for fixing the position of the launch. The launch would steam as slowly as possible across river but there was often a tide running at 2 feet per second so that it was not going any too slowly. The greatest difficulty was in getting the sailors to take soundings in 40 feet of water quickly enough. The actual sounding in the river did not take long but the time was spent in getting tide gauge readers to the gauges and placing flags on the triangulation stones. Flags and poles had to be taken down at night as the flags were 4 feet square and were valuable to the natives as clothes for children and any flag left up over night was gone in the morning.

Current observations were also taken at various points on the river and bar with a current meter, but as the direction of the tide was often of more interest than the speed, floats were used most of the time. These floats were made from half of a 5-gallon oil can with a weight made of sheet lead and constructed so as to offer as much resistance to the current as possible suspended from the under side. The floats were followed in a sampan and their position fixed as often as desired.

The object of the Conservancy was to aid shipping to the port of Newchwang and it was realized that one way to assist would be in tide predictions. The tides over the Newchwang bar were a combination of the diurnal and the semi diurnal and the result was to give a large diurnal inequality in the height of high water. This caused the high water that occurred in the late afternoon and evening to be as much as 4 feet higher than the high water occurring in the morning. Therefore if the tides could be predicted reasonably accurately steamers could take advantage of the higher high water at all times and so load more cargo. The Liao river is situated at the head of the Pei Chihli Gulf and forms a bottle neck and with a strong southerly

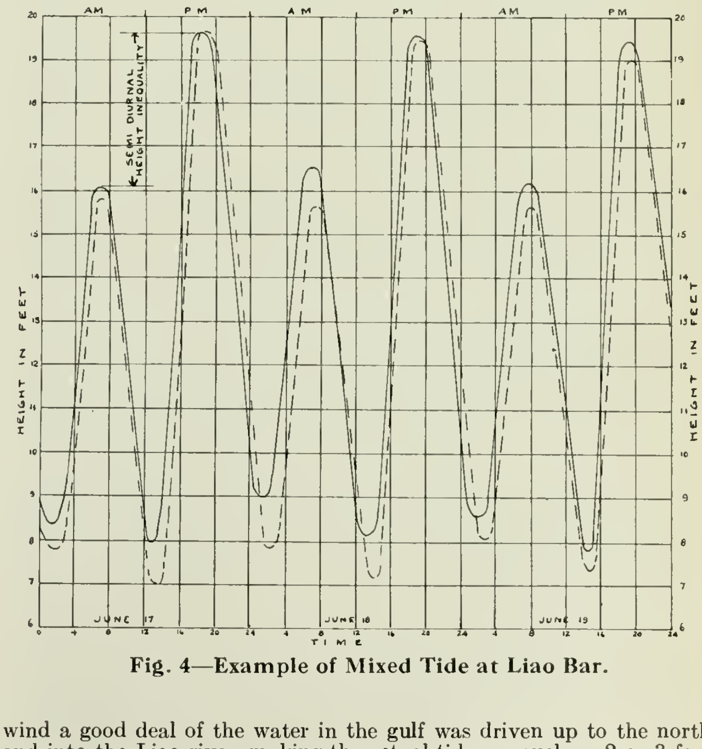

Fig. 4—Example of Mixed Tide at Liao Bar.

wind a good deal of the water in the gulf was driven up to the north and into the Liao river, making the actual tide as much as 2 or 3 feet above normal, and the reverse took place with a north wind. In order to predict tides it is necessary to have one year's tidal records to predict from but with so much wind at Newchwang it was necessary to take two or three years' tides in order to get away from the effect of the wind.

The author was not at the time acquainted with any method of tide prediction but after some study finally predicted tides for the bar. These predictions were issued in small books to the shipping companies and captains of steamers using the port and proved very useful. Figure 4 shows actual tides and predictions with predicted heights as a dotted line.

Work on the Bar

The main work of the Conservancy was the construction of the east training wall and the west channel closure. See Fig. 2. As mentioned previously Mr. Hughes had from 1916 to 1919 constructed the west channel closure and the east training wall from No. 5 Beacon to Mound Beacon. The closing of the west channel had helped to some extent in increasing the speed of the ebb tide over the bar but the main work was to push out the east training wall quickly in order to gain advantage of the increased scouring effect. The wall was carried on from Mound Beacon and in 1925 extended past the middle buoy. The stone used for the training wall was not all that could be desired as regards size. Owing to financial difficulties large plant to handle large sized stone could not be purchased and all stone used was placed by hand, which limited the size, though no stone was to weigh less than 66 pounds. The stone for the wall came by train from quarries at Ta Shih Chiao some 20 miles east of Newchwang. During the summer ten cars of stone arrived daily. The stone was brittle and with the loading on to cars at Ta Shih Chiao, unloading at Newchwang and loading and unloading on the bar, it broke up considerably. For transporting the stone there was a 94-foot sea-going tug and three barges. Two of the barges carried a deck load of 200 cubic yards each and were 110 feet long, 20-foot beam. The third barge was a self-dumping hopper barge 120 feet long, 22-foot beam and carried 220 cubic yards of stone. These barges were loaded by hand at the docks in Newchwang, which took two hours, and towed to the bar. Arrived at the bar the two barges with a deck load would moor, usually one on either side of the wall, and the stone was dumped on the wall by hand again. This also took about two hours. The hopper barge had large doors in the bottom of the hopper and was moored over the end of the wall where there was no stone and the doors opened. As all unloading was done on the ebb tide the arrangement worked out very well as the hopper barge could start the wall and the other two barges finish it to proper height. The wall was built up to 3 feet above low water and was approximately 10 feet high in all. The ice action in the winter and seas in the summer flattened it out a great deal and building was continued until such time as the stone found its own angle of repose. There were also twelve stone-carrying junks with a capacity of 28 to 50 cubic yards of stone. These were used in maintaining the older part of the wall and the west channel closure and filling up any gaps left by the barges.

There was also good stone available at Kaichow which is 13 miles by water south east of the end of the training wall. This stone was of better quality and cheaper than that at Ta Shih Chiao but there was no harbour at Kaichow and no docks. However it was decided to investigate the feasibility of taking the barges there. At low water there was no water at all on the shore, which meant at high water there was from 9 to 14 feet. The tug drew 9 feet of water and at one place there was a small point jutting out which afforded slight protection from the sea. It was therefore decided that it could be done and a wharf was built to accommodate the three barges and also hold a reserve supply of stone. The barges usually unloaded on the bar at low water and as soon as the tide rose a little the tug would pick them up and head for Kaichow. The trip took about three hours and by that time there would be sufficient water at the docks for the barges to go alongside. The tug would steam in at full speed and as soon as the water became too shallow she would swing around and let the barges go and they usually had sufficient way to make the dock. Loading took about two hours and by that time the tide would be sufficiently high for the tug to come in and pick up the barges. This was the schedule but for emergencies a large anchor was dropped out in deep water and a cable run from it to the dock. When the barges were loaded and there was not enough water for the tug the crew took a turn or two of the cable around their own winch and pulled out to the tug. The stone at Kaichow was quarried from the hills in the immediate vicinity and hauled to the dock in two wheeled carts. The carts were made entirely of wood including the axle and were of the same design as used in China some two thousand years ago. These carts carried about one cubic yard of stone, and were drawn by two horses, one mule and a donkey or any other arrangement of animals that the owner possessed.

The work required at times a good deal of ingenuity due to the almost complete lack of mechanical equipment. The only available power was the tug and launches. Everything else was done by hand. Concrete mixed by hand, piles driven by hand and stone loaded and unloaded by hand. The wages for coolie labour were about $4.50 per month and at that without board so that mechanical methods simply could not compete with labour. All lumber used was purchased in logs and sawn and dressed by hand. The dock built at Kaichow was constructed of concrete piles and 3- by 18-inch concrete planks to form a bulkhead. The whole of this work was made in Newchwang by hand, loaded and unloaded by hand at Kaichow and the piles driven by hand. The piles ranged from 18 to 25 feet in length.

In 1927 the east training wall had been constructed to a point well past the middle buoy, the total length being 36,000 feet. 510,000 cubic yards of stone had been placed on this wall and 54,000 cubic yards used on the west channel closure. The wall had been pushed out as quickly as possible to obtain the scouring effect on the bar and still required a great deal of stone to complete it. The cost of the stone laid down on the wall including all charges was $2.00 per cubic yard.

Figure 2 shows some of the results accomplished by the training wall, which were very gratifying. Before the wall was started the depth at low water on the bar was 6 feet but the six-foot contour had not broken through the bar. This contour finally broke through and later the seven-foot contour. In 1917 the nine-foot contour on the inside of the bar ended at Mound Beacon and in 1923 it had advanced to a point past the middle buoy, a total advance of 11,500 feet. In 1917 the distance from 9 feet of water outside the bar to 9 feet inside was three miles and in 1923 this had been reduced to one mile. The length of the bar had therefore been decreased by two miles and the depth increased by one foot. The consulting engineers had recommended the purchase of a dredger when the wall reached the middle buoy so that a channel could be started across the remainder of the bar which would materially assist in cutting through; however, finances at the time did not permit this.

It has been calculated that a total of 18½ million cubic yards of material was scoured off the bar between 1917 and 1925. The total cost of the work was roughly one million dollars or just a little over 5 cents per yard. A dredger could have taken it off much quicker but not as cheaply.

The Association of Professional Engineers of the Province of British Columbia

QUALIFICATIONS

LEADING TO A LICENCE TO PRACTISE

For University Applicants

"Engineering Pupil"—In British Columbia undergraduates enroll as "Engineering Pupils" in the third year of a five year course.

"Engineer-in-Training"—On graduation, graduates enroll as "Engineers-in-Training"; are formally welcomed into the Profession by means of a suitable ceremony held in their honour by the Council of the Association (part of the ceremony being, "The Order of the Calling of an Engineer"). An Entrance Fee of $10.00 becomes payable in the year subsequent to the year of graduation and an Annual Fee of $5.00 in succeeding years.

"The Licence to Practise" constitutes the highest honour at the disposal of the Engineering Profession and this is granted to graduates who, after four or five years of practical work and having paid their fees as Engineers-in-Training for this period, present a worth-while professional thesis of from five to ten thousand words, based on the work that they have enjoyed or been in contact with subsequent to graduation.

The theory or principle underlying the granting of a licence to practise is that which guides all the other professions, namely that those applicants who have successfully passed through the officially prescribed education, the officially prescribed junior experience and the official tests, deserve complete and full recognition. (Entrance Fee $35.00. Annual Fee $10.00.)

For Non-University Applicants

Non-university applicants, who must possess JUNIOR MATRICULATION, can obtain a licence to practise by passing three examinations, Preliminary, Intermediate and Final, together with a professional thesis. Semi-annual Examinations October 28th, 1935 and April 27th, 1936.

Further information can be obtained from:

THE REGISTRAR

The Association of Professional Engineers of the Province of B.C.
930 Birks Building, Vancouver, B.C.
Seymour 1827

The Lachine sheet of the National Topographic series of maps recently issued by the Geographical Section of the Department of National Defence provides a comprehensive view of the southern half of the island of Montreal, showing about one-half of greater Montreal, including Westmount, Montreal West and Bellevue, together with the area south of the St. Lawrence river in which are located Beauharnois, Caughnawaga, Chateauguay, Delson and St. Remi. In conjunction with the Laval sheet issued earlier in the year, the two maps almost completely cover the island of Montreal and a considerable area north and south of the St. Lawrence river.

The sheet is distributed by the Topographical and Air Survey Bureau, Department of the Interior, Ottawa, from which source copies may be obtained for 25 cents each.

Preliminary Notice

of Applications for Admission and for Transfer

September 30th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in November, 1935.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

ANDERSON—HOPE VERE, of 102 Fentiman Ave., Ottawa, Ont., Born at Motherwell, Scotland, Dec. 10th, 1890; Educ., 1906-10, Glasgow and West of Scotland Tech. Coll.; 1907-10, premium ap'tice. with Messrs. Alley and McLellan, Glasgow. Pattern-making, fitting, erecting and testing divn., drawing office; 1910-13, designing dftsman., as follows: 1910-11, G. & J. Weir, Glasgow; 1911-12, Mimlees Watson, Glasgow; 1912, International Marine Signal Co., Ottawa; 1913, Dept. of Mines, Ottawa; 1913-24, mech'l. engr., and 1924 to date, senior asst. engr., Dept. of Marine, Ottawa, Ont. Work includes inspection of sites for new projects and reports thereon. Design of lighthouse piers, timber and reinforced concrete, steel towers, protection works, depot wharves and workshops, optic apparatus, etc.
References: L. F. H. deMiffonis, J. G. Macphail, C. P. Edwards, C. M. Pitts, E. Gohier, J. L. Busfield.

ARMSTRONG—THOMAS CHAPMAN, of 285 Argyle St., Port Arthur, Ont., Born at Kenora, Ont., Sept. 23rd, 1908; Educ., 1928-30, Queen's Univ.; 1927-28, asst. to chief mining engr., Noranda Mines Ltd.; 1930-31 (6 mos.), instr'man. and dftsman., Dept. Public Highways Ontario; 1931-32, dftsman., 1932-33, asst. to engr. on constrn., and 1933 to date, chief dftsman., Dept. Northern Development, Thunder Bay District, in charge of all plans for layout and highway constrn., timber trestles, concrete bridges and abutments, engrg. estimates, etc.
References: T. S. Armstrong, W. P. Wilgar, G. R. McLennan, J. M. Fleming, H. G. O'Leary.

FRASER—INNES MARTELL, of 301 Portland St., Dartmouth, N.S., Born at Rawdon, N.S., July 17th, 1911; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1934; 1932 (summer), transitman on survey; 1934 to date, potentiometer mtce. man., Imperoyal, Dartmouth, N.S.
References: R. L. Dunsmore, W. P. Copp, H. R. Theakston, F. R. Faulkner, A. R. Chambers, A. G. Tapley, R. B. Stewart, G. H. Burchill.

FRY—EDMUND BOTTERELL, of Red Lake, Ont., Born at Westmount, Que., July 18th, 1902; Educ., B.Sc. (Mech.), McGill Univ., 1925; Grad., R.M.C.; Summers: 1923, material man on constrn., E. G. M. Cape & Co.; 1924, instr'man., on survey, Ontario Paper Co.; 1925 (July-Dec.), shop course, Canadian Ingersoll Rand Co. Ltd.; 1926-30, with Can. Ingersoll Rand Co. Ltd., as follows: 1926-27, asst., pump dept., head office; 1927-28, sales engr., Toronto office; 1928-29, temp. mgr., pump dept., head office; 1929-30, district engr., Toronto office i/c complaints, service, engrg. details, etc.; 1930-31, asst. to gen. mgr., mech'l. sales, statistics and engrg. details, Dominion Rubber Co. Ltd., and 1931-32, asst. to mgr., mech'l. sales, eastern divn., of same company, correspondence, quotations, etc.; Dec. 1933 to date, mech'l. engr. and surveyor, Howey Gold Mines Ltd., Red Lake, Ont. Surface and underground surveying, mech'l. dfting. and design.
References: L. E. Schlemm, F. P. Shearwood, R. M. Calvin, E. C. Hague, J. G. Notman, A. S. Rutherford, E. Winslow-Spragge.

KATZ—LEON, of 28 Pine St., Kingston, Ont., Born at Tristin, Ukrania, Aug. 9th, 1910; Educ., B.Sc., Queen's Univ., 1934; Summers 1926 and 1928, with James Morrison Brass Co. and Acme Screw and Gear Co.; 1931 and 1932-33, research on batteries, and 1934 to date, foreman, Monarch Battery Mfg. Co. Ltd., Kingston, Ont.
References: D. M. Jemmett, A. Jackson, W. L. Malcolm, L. T. Rutledge.

McGUIRE—JAMES FRANCIS, of 3617 St. Famille St., Montreal, Que., Born at Montreal, Nov. 23rd, 1908; Educ., B.Eng. (E.E.), McGill Univ., 1934; Aug. 1934 to date, ap'tice., Montreal Armature Works, Montreal, Que.
References: E. A. Ryan, R. DeL. French, C. V. Christie, C. M. McKergow, F. M. Wood.

REID—CHARLES ROY, of 2070 Peel St., Montreal, Que., Born at Marion, Oregon, Dec. 14th, 1879; Educ., B.S. in E.E., 1906, M.E.E., 1912, Univ. of Oregon. M.M.E. in E.E., Cornell Univ., 1916; 1900-02, electrn. and operator, Portland General Electric Co., Portland, Ore.; 1906-15, instructor and professor in electr'l engrg., University of Oregon; 1916 to date, with the Shawinigan Water and Power Company, Montreal, as follows: 1916-18, elect'l. engr., operating dept.; 1918-30, power house supt.; 1930 to date, asst. gen. supt.
References: J. Morse, E. Brown, C. V. Christie, P. S. Gregory, J. A. McCrory, G. R. Hale, W. R. Way, H. S. Van Patter.

STUART—THOMAS CHARLES, of Montreal, Que., Born at Napier, New Zealand, March 29th, 1906; Educ., 1923-28 (winters), Glasgow University (took B.Sc. course in mech. engrg., but did not graduate). 1923-28 (summers), ap'ticeship. served in mech. engrg. with Scotts Shipbuilding and Engrg. Works, Greenock, Scotland; 1928, shop and drawing office work with Canadian Ingersoll Rand Co.; 1928 to date, with Dominion Welding Engineering Co. Ltd., Montreal, responsible for design and execution of welding work.
References: J. H. Wallis, H. M. Lyster, H. G. Welsford, F. C. Mechin, A. D. Ross, E. B. Jubien, R. S. Eadie.

WEBSTER—FREDERICK HENRY THOMAS, of 2278 Oxford Ave., Montreal, Que., Born in Gloucestershire, England, Jan. 4th, 1893; Educ., I.C.S. Locomotive Engrg. Grad. of Shaw Schools Ltd., Stationary Engrg. 1st Class Quebec Cert.; 1906-10, ap'ticeship. to fitter and machinist; 1910-12, ap'ticeship. to boilermaker; 1912-17, locomotive fireman and engineman, C.P.R., Toronto; 1917-18, chief engr., power house, Lambton round house; 1918-19, night chief engr., Russell Motor Car Co., Toronto; 1919-20, asst. mech. supt., Corby Distillery Co. Ltd., Corbyville, Ont.; 1920-21, asst. engr., Swift Canadian Packers, West Toronto; 1921-22, asst. engr., Cosgraves Brewery, Toronto; 1922-23, Second Engr., S.S. Brantford, Sowards Coal Co., Kingston, Ont. (1st Class Ontario Cert.); 1923-24, chief engr., Mandle Bros. warehouse, Chicago; 1924-26, machinist and fitter, Lightmore Colliery, Gloucester, England; 1926-29, engr. on deep sea ships, various companies; 1929-30, asst. engr., Robert Simpson Co., and acting chief engr. during constrn. of new Star Office, Montreal; 1930-32, chief engr., Beaconsfield Golf Club, under constrn. and operation; 1932, chief engr., Hart Battery Co , St. Johns, Que.; 1932 to date, chief engr., Homeopathic Hospital of Montreal.
References: D. F. Grahame, E. A. Ryan, F. A. Combe.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

GAUTHIER—PAUL GILLES, of 660 de L'Epee Ave., Outremont, Que., Born at Montreal, Que., March 31st, 1900; Educ., B.Sc. (C.E.), McGill Univ., 1921; License to practise (by exam.) Corpn. of Quebec Land Surveyors; Summers: 1918-19, rodman, Quebec Streams Commn.; 1920, instr'man., Riordon Company; 1921-22, engr. on location, Ministry of Colonization, Quebec Govt.; Winter 1921-22 and Fall 1922, instructor in descriptive geometry, etc., engrg. faculty, McGill Univ.; 1923-25, charge of field party doing layout work and inspection and installn. of constrn. plant, etc., at Isle Maligne development, for Duke-Price Power Co.; 1925 (June-Oct.), charge of 50-man party making topography survey (10 sq. miles) for use in locating site for aluminum plant and for town plan of proposed city of Arvida; 1925-26, in charge of field engrg. for constrn., of roads, water lines, sewers, etc., for city of Arvida, for Aluminum Company of Canada; 1926-27, charge of location of 35-mile 110-k.v.a. transmission line, for Duke-Price Power Company; 1927-28, charge of field engrg. for installn. of constrn. plant and excavation of bypass channel for hydro-electric development at Chute a Caron, for Alcoa Power Company; 1928-30, cost engr. on same development for same company; 1930-34, res. engr. Section 4, Beauharnois power development; 1934 (Jan.-Feb.), private practice as Q.L.S., making legal boundary survey of estate having 10 miles of boundary; 1934 (Feb.-May), private research on special type of floor surfacing material for use in factory and office floors; 1934 (May-June), re-establishing gauges in Beauharnois section of St. Lawrence River and tying these with Geodetic datum for Beauharnois L.H. & P. Co.; 1934 (June-Dec.), in charge of location and final staking of new 75-mile highway from Rouyn to Senneterre, for Dept. of Mines, Quebec Govt.; at present, private practice as Civil Engineer and Quebec Land Surveyor. (*St. 1919, Jr. 1922, A.M. 1928.*)

References: F. H. Cothran, R. DeL. French, J. A. Knight, O. O. Lefebvre, D. F. Noyes, M. V. Sauer, H. R. Wake, R. White.

TOOKER—GUY LANGRISHE, of 1272 Connaught Drive, Vancouver, B.C., Born at Tenby, South Wales, Sept. 18th, 1884; Educ., 1899-1902, Prince of Wales College, Charlottetown, P.E.I.; 1902-04, ap'tice., Locomotive and Machine Co., Montreal; 1904-08, rodman, topogr., leveler, transitman, T.C. Rly., Quebec; 1908-10, transitman, G.T.P. Rly., Prince Rupert, B.C.; 1910-11, with Ritchie Agnew & Co., as asst. engr. on surveys and constrn. of water and sewerage systems for City of Prince Rupert; 1911-12, in charge of parties making surveys for the proposed future water supply and hydro-electric development for the same city; 1912-13, with Prince Rupert Hydro-Electric Co., asst. engr. i/c parties making complete topog'l. drainage area and trans. line surveys for proposed developments; 1913 (Mar.-Aug.), asst. engr. i/c constrn. of rock filled crib dam across Falls River; 1913-15, asst. surveyor on land tie and right of way surveys, G.T.P. Rly.; 1915-19, overseas, C.E.F.; 1919-20 and 1922 (May-Nov.), leveler and dftsman., C.N.R.; 1922-24 and May 1925 to Feb. 1926, with Noel Humphreys & Co., Civil Engrs. and Surveyors, instr'man. and asst. on various surveys; Oct. 1924 to May 1925 and 1926 (Mar.-June), asst. surveyor, C.N.R., right of way dept., main line and Vancouver Is. branch lines; 1926-29, instr'man., engrg. dept., 1929-33, asst. engr., roads dept., i/c of design and constrn. of Macadamized roads throughout the Greater Vancouver District, and 1933 to date (due to reduction of staff), instr'man., City of Vancouver, B.C. (*St. 1904, Jr. 1913, A.M. 1930.*)

References: D. O. Lewis, W. B. Greig, W. P. Wilgar, R. Rome, E. C. Thrupp.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BENJAMIN—ABRAHAM, of 1080 Lajoie Ave., Outremont, Que., Born at Glace Bay, N.S., Dec. 23rd, 1900; Educ., B.Sc., McGill Univ., 1924; 1925-29, with Electrical Commn. of the City of Montreal, in charge of expropriation and contract payments; 1929 to date, electric substation designer, Montreal Light, Heat and Power Cons., Montreal. (*St. 1921, Jr. 1928.*)

References: G. E. Templeman, G. C. Reid, H. Milliken, R. M. Walker, C. V. Christie, G. A. Wallace.

BOWN—CHARLES ROY, of 5404 Clanranald Ave., Montreal, Que., Born at Sydney, N.S., Dec. 10th, 1900; 1918-19, and summers 1920-22, helper in foundry, machine shop, etc., and tracer in drawing office, Dom. Iron and Steel Co., Sydney, N.S.; 1923-24, dftsman., Can. Mead Morrison Co., Welland, Ont.; 1924-26, mechanic's helper on constrn. of power stations for Stone & Webster Inc.; 1926-32, mech'l. inspector for same company on erection of mech'l. equipment in various power houses and industrial plants; 1932 to date, asst. chief engr., Canada and Dominion Sugar Co. Ltd., Montreal, Que. (*St. 1921, Jr. 1925.*)

References: K. G. Cameron, C. M. McKergow, A. W. McMaster, H. M. Black, R. A. Gurnham, D. A. Killam, E. B. Jubien.

HARRIS—ARTHUR CLIFFORD, of 256 Almon St., Halifax, N.S., Born at Halifax, Dec. 7th, 1900; Educ., B.Sc. (C.E.), N.S. Tech. Coll., 1927; 1925-26 (summers), with the City of Halifax; 1927, Dom. Bridge Co. Ltd.; 1928, N.S. Steel and Eastern Car Works; 1928 to date, asst. engr., City of Halifax, N.S. (*St. 1927, Jr. 1928.*)

References: F. R. Faulkner, W. J. DeWolfe, H. W. L. Doane, W. P. Copp, R. M. McKinnon.

HOLDEN—JOHN HASTIE, of Westmount, Que., Born at Westmount, May 20th, 1902; Educ., B.Sc., McGill Univ., 1923; 1922 (summer), dftsman., Shaw. Engrg. Co.; 1923-24, asst. to plant engr., Northern Electric Co. Ltd.; 1924-31, asst. to head estimator and chief dftsman., and 1931 to date, sales manager, in charge of sales and statistics, giving technical information regarding products, Geo. W. Reed & Co. Ltd., Montreal, Que. (*St. 1921, Jr. 1930.*)

References: B. R. Perry, W. G. Hunt, J. F. Plow, A. S. Rutherford, A. T. Bone.

McBRIDE—ERNEST WILLARD, of 86 High Park Ave., Toronto, Ont., Born at Churchville, Ont., July 24th, 1901; Educ., B.A.Sc., Univ. of Toronto, 1923; Summer work: (1) Willis Overland Electric shop; (2) Hollinger Gold Mines; (3) Bakelite Corpn.; 1923 (6 mos.), research work, Canada Paper Co., Windsor Mills, Que.; 1923 (3 mos.), research work, Univ. of Toronto; 1924-30, Abitibi Power and Paper Co., Iroquois Falls, 1 year, engr. on statistics, 2 years, asst. to control engr., 3 years, in charge of control dept.; 1930 to date, technical engr. with same company at Toronto, Ont. (*St. 1920, Jr. 1928.*)

References: F. L. Mitchell, T. R. Loudon, A. M. Reid, J. W. Dyer, E. L. Goodall, H. O. Brown, G. W. Holder.

PINEAU—MAURICE, of 1377 Fleury St., Montreal, Que., Born at Mussidan, France, March 6th, 1902; Educ., 1924-27, Montreal Technical School. Passed Institute's exams. under Schedule "B" for admission as Junior Nov. 1932; 1927-29, heating and engrg. depts., Crane Limited, Montreal. In charge of design of heating systems of all descriptions. Design of boiler plants. Research work in design and testing of boilers and radiators. High and low pressure piping layouts; 1929-32, with McDougall & Friedman, Consltg. Engrs., Montreal. Design and layout of boiler plants. High and low pressure piping layouts. Ventilating, air conditioning and plumbing systems for large public bldgs., hospitals, etc. Specifications, estimates, supervision and inspection during constrn.; 1932-34, doing similar work to above for McDougall & Friedman, Raoul Lacroix, Architect, and L. A. St. Pierre, Consltg. Engr.; 1934 (June-Nov.), with Canada Paper Co., Windsor Mills, Que., in charge of design and erection of a 3,400-ft. outside h.p. steam line; Jan. 1935 to date, heating and engrg. depts., Crane, Limited, Montreal. In charge of engrg. pertaining to the heating dept. Design of pipe bends and fabrication in the engrg. dept. (*Jr. 1932.*)

References: G. K. McDougall, T. E. McGrail, C. P. Creighton, F. J. Friedman, J. D. Fry, J. A. Kearns, H. L. Johnston.

SEVIGNY—JOSEPH ALFRED, of 733 St. Cecile St., Three Rivers, Que., Born at St. Angele de Laval, Que., Feb. 13th, 1902; Educ., 1918-22, Grad., De La Salle Academy, Three Rivers; Passed E.I.C. Exams. under Schedule "B" for admission to class of Junior, 1933; With the St. Lawrence Paper Mills Co. Ltd., Three Rivers, as follows: 1923-25, steam clerk; 1925-26, dftsman.; 1927-28, in charge of control work, control dept.; 1928-32, chief dftsman., and 1932 to date, chief dftsman. and asst. to plant engr. (*St. 1925, Jr. 1933.*)

References—F. O. White, R. L. Weldon, B. Grandmont, K. S. LeBaron, J. F. Wickenden.

WILSON—ARCHDALE McDONALD, of 223 Pilgrim St., Sault Ste. Marie, Ont., Born at Hamilton, Ont., Oct. 7th, 1899; Educ., B.Sc., Queen's Univ., 1928; 1918-20 and summers 1922-27, chainman, rodman and instr'man., T.H. & B. Ry., Hamilton, Ont.; 1928 to date, asst. engr., Algoma Central and Hudson Bay Rly., Sault Ste. Marie, Ont. (*Jr. 1929.*)

References: R. S. McCormick, A. E. Pickering, E. M. MacQuarrie, H. B. Stuart, R. L. Latham.

FOR TRANSFER FROM THE CLASS OF STUDENT

BARBOUR—CLARENCE ALLEN, of Saint John, N.B., Born at Saint John, Feb. 14th, 1906; Educ., B.Sc. (E.E.), Univ. of N.B., 1931; Summers: 1929-30, N.B. Telephone Co. Ltd., 1931, Saint John Harbour Commission; 1931-32, asst. engr., Canadian Comstock Co., and journeyman electrn., Sterling Electric Co. Ltd.; 1932 to date, proprietor, Maritime Radio and Electrical Supplies, Saint John, N.B. (*St. 1930.*)

References: W. J. Johnston, A. Gray, A. F. Baird, A. A. Turnbull, J. Stephens.

BENNETT—ARTHUR J., of Montreal, Que., Born at River Desert, Que., April 23rd, 1904; Educ., B.Sc. (E.E.), McGill Univ., 1927; Summers: 1924, rodman on survey, Dept. Nat. Defence; 1925-26, instr'man., Beatty & Beatty; 1927-28, layout and survey of toll lines, Quebec Divn., outside plant, Bell Telephone Co. of Canada; 1929 to date, sales engr., English Electric Co. of Canada Ltd., Montreal, Que. (*St. 1925.*)

References: G. Kearney, C. V. Christie, A. D. Ross, H. M. Black, R. DeL. French, K. O. Whyte, R. H. Balfour.

CUNNINGHAM—GEORGE ALLIN, of 331 Reid St., Peterborough, Ont., Born at Peterborough, May 1st, 1908; Educ., B.A.Sc., Univ. of Toronto, 1929; Summers: 1926, machine shop, Wm. Hamilton Ltd.; 1927, bldg. constrn., A. B. Cunningham, contractor; 1928, asst. to mgr., Peterborough Public Utilities; 1929-31, asst. chief engr., Riley Engineering and Supply Co. Ltd., Toronto, also in charge of design and production of materials handling divn.; 1932 to date, district representative, Imperial Oil Ltd., selection and specification of lubricants and fuels for internal combustion engines, installn. and operation of combustion systems, recommendation of industrial lubricants, and management of operating personnel. (*St. 1927.*)

References: R. L. Dobbin, E. A. Allcut, A. B. Gates, R. H. Parsons, V. S. Foster.

DOBRIDGE—RONALD WEMYSS, of 41 Dobie Ave., Town of Mount Royal, Que., Born at St. Kitts, B.W.I., Sept. 26th, 1905; Educ., B.Sc., 1928, M.Sc. (Physics), 1929, McGill Univ.; 1926 (summer), rodman, C.P.R., Ottawa; 1928 (summer), engr., Northern Electric Co., Montreal; 1929-33, engr., Bell Telephone Co. of Canada, Montreal; Oct. 1934 to date, transformer engr., Canadian Marconi Company, Montreal. (*St. 1928.*)

References: J. H. Thompson, W. H. Moore, E. W. Farmer, J. L. Clarke.

HAMILTON—ROBERT WILLIAM, of 113 Brock Ave. South, Montreal West, Que., Born at Montreal, November 16th, 1907; Educ., B.Sc. (E.E.), McGill Univ., 1929; 1926 (summer), sketching and checking constrn. of paper mill foundations, Fraser Brace Engrg. Co.; With the Dominion Electric Protection Company as follows: 1927 (summer), installing signal systems; 1928 (summer), installing switchboards, generators in central station at Montreal; 1929-30, junior engr in charge of development of new apparatus; 1930 to date, electrical engr. Full charge of engrg. dept. located at Montreal which serves central stations at Winnipeg, London, Hamilton, Toronto, Ottawa, Montreal and Quebec, and factory at Montreal. (*St. 1925.*)

References: D. C. Tennant, C. V. Christie, R. E. Jamieson, C. B. Brown, G. E. Templeman.

HART—WILLIAM O., of 431 Simcoe St. South, Oshawa, Ont., Born at Bowmanville, Ont., June 24th, 1906; Educ., B.Sc., Queen's Univ., 1929; 1925 (June-Aug.), pipe fitting for H.E.P.C. at Hydro, Ont.; With the General Motors Company of Canada, Oshawa, Ont., as follows: 1928 (May-Aug.), reject dept. mechanic; 1929-30, salvage dept.; 1930-33, technical clerk, body plant office, in charge of engrg. and production records in body plant and inspection office; Sept. 1933 to Mar. 1935, inspection supervisor of body shop, mill rooms and garnish moulding inspection; at present, advertising and sales mgr., Oshawa Dairy Ltd., Oshawa, Ont. (*St. 1928.*)

References: F. Chappell, D. M. Jemmett, A. Macphail, L. T. Rutledge, D. S. Ellis.

HUTTON—JOHN R., of 123 Bold St., Hamilton, Ont., Born at Halifax, N.S., June 2nd, 1905; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1927; With Canadian Westinghouse Co. Ltd., as follows: 1927-29, student apprentice; 1929-32, illumination divn.; 1932-35, correspondence and sales, and at present engr., lamp dept. (*St. 1925.*)

References: F. R. Faulkner, D. W. Callander, W. F. McLaren, J. R. Dunbar, H. U. Hart, G. W. Arnold.

LOCHHEAD—KENNETH YOUNG, of Winnipeg, Man., Born at Lachine, Que., Sept. 26th, 1907; Educ., B.Eng. (C.E.), McGill Univ., 1932; 1930 (summer), student engr., Montreal Harbour Commn.; 1931 (summer), student engr., Dominion Bridge Company; 1932-33, demonstrator, mech'l. engrg. laboratory, McGill University; at present, asst. to supt. of bldgs., Hudson's Bay Company, Winnipeg, Man. (*St. 1931.*)

References: H. M. White, G. J. Dodd, C. M. McKergow, E. Brown.

MacGREGOR—JAMES GRIERSON, of Vegreville, Alta., Born at Dornoch, Scotland, June 2nd, 1905; Educ., B.A., B.Sc., Univ. of Alta., 1929; 1928, smoke testing, etc., Cons. Mining and Smelting Co., Trail, B.C.; 1929, meter testing, line constrn., 1929-31, office work in all branches of electric utility, including rates, valuation, constrn., and from 1931 to date, district supt., Lloydminster-Vegreville district, Canadian Utilities Limited. (Two diesel generating plants, 155 miles transmission line serving 14 towns and villages. In charge of operation, mtce., new constrn., rates, collections and merchandise.) (*St. 1929.*)

References: E. W. Bowness, R. S. Trowsdale, C. A. Robb, H. J. MacLeod, R. S. L. Wilson.

MOLLARD—JOHN ELLIS, of Tisdale, Sask., Born at Grand Bend, Ont., Sept. 1st, 1903; Educ., B.Sc. (M.E.), Univ. of Sask., 1931; With the Dominion Electric Power as follows: Jan. 1926 to Oct. 1927, plant operator, Biggar, Sask.; Oct. 1927 to July 1928, plant mgr., Gravelbourg, Sask.; 1928 (July-Oct.), 1929 (May-Oct.), and 1930 (May-Oct.), line foreman at Shaunavon and Estevan; With the Saskatchewan Power Commission as follows: 1931 (June-Sept.), constrn. dept., Regina; Oct. 1931 to Jan. 1932, operator, operating dept., Humboldt, Sask.; Feb. 1932 to date, supt., Tisdale, and at present, district supt. (Diesel electric plant, distribution systems, and 13 k.v. transmission line). (*St. 1931.*)

References: C. J. Mackenzie, L. A. Thornton, R. W. Jickling, I. M. Fraser, W. E. Lovell.

McINTYRE—DOUGLAS VALLANCE, of Rouyn, Que., Born at High River, Alta., April 28th, 1903; Educ., B.Sc. (E.E.), Univ. of Alta., 1931; 1928, constrn. survey, E.D. and B.C. Rly.; 1931-32, electrn. (constrn.), Gen. Elec. Company; 1933, track relay, C.N.R.; at present, electrn., McWalters Gold Mines, Ltd., Rouyn, Que. (*St. 1930.*)

References: H. J. MacLeod, W. E. Cornish, H. R. Webb, P. F. Poole.

RYDER—FREDERICK JAMES, of 1430 Giles Blvd. East, Windsor, Ont., Born at Holyoke, Mass., June 28th, 1907; Educ., B.Sc. (C.E.), McGill Univ., 1929; Summers: 1926-27, rodman and chainman, C.N.R.; 1928, instr'man., Laurentide Pulp and Paper Co., Grand'Mere, Que.; 1929-32, dftsman., Canadian Bridge Co., Walkerville, Ont.; 1932 to date, with Motor Products Corpn. Ltd., Walkerville, Ont., material dept. and gen. office work. (*St. 1928.*)

References: E. M. Krebser, H. J. A. Chambers, R. C. Leslie, F. Stevens, D. T. Alexander, A. E. West.

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CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., A.M.A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

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CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

Situations Wanted

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, B.SC. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, S.E.I.C., B.SC. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.SC., '25, JR.E.I.C., P.E.Q, married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.SC. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

Situations Wanted

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.SC. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.SC. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.SC. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

Situations Wanted

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.SC. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.SC., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.SC. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.SC., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

Situations Wanted

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.SC., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.SC. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.SC. '34 (Univ. of N.B.). S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.SC. '32, M.SC. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.SC., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, JR.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.SC. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

Telephones

World telephone statistics recently issued for 1934* will impress all engineers with the growth and development of telephone service during the past sixty years. It is difficult to conceive of such a development taking place in so short a period, but the first record of the use of the term "telephony" only occurred in a lecture delivered before the Physical Society of Frankfort in 1861 by Philipp Reis, the experiments of Alexander Graham Bell taking place only ten years later, between 1874 and 1876. In 1934, 32,495,855 telephones were in use in the world; an astonishing figure, yet only 1.54 telephones for each one hundred of the population. Some 14,300,000 of these are automatic or dial telephones of which 46 per cent are in the United States.

The United States, where the earliest developments occurred, has continued to be the leader in the number of installations, and now has 51.4 per cent of the total instruments in the world, or 13.29 telephones per one hundred population. Canada ranks second with 1,192,330, or 11.15 telephones per one hundred population. New Zealand is third and Denmark fourth. Great Britain is the leader of the major European countries with 4.78, ranking tenth; Germany, which has almost three million telephones and is second to the United States in the number of instruments installed, holds eleventh place with 4.48. In Asia, Japan is the outstanding country with 1.50 telephones per one hundred of population and Argentina in with South American countries with 2.64.

Canada, with 84 per cent of telephones under private management, ranks second to the United States in this respect. As a striking contrast there are the three major European countries, Great Britain, Germany and France with telephone services exclusively operated by the government.

Washington, D.C. is the leader in telephone development among the large cities of the world, with 35.31 telephones per hundred of population. Vancouver in fifth place is the leader of the Canadian cities with 27.51, Toronto ranking ninth with 24.44; Ottawa has 18.88 and Montreal 16.14 telephones per one hundred population. Stockholm, the leading European city, has a development of 31.95, New York 20.83, Paris 14.18, Berlin 10.85 and London 9.07 telephones per one hundred population.

Interesting figures and annual surveys show an unmistakable trend towards still greater usage in every country. This however is not to be wondered at when the recent technical advances in the telephone art are considered, and long distance transmission, radio and carrier current telephony and automatic systems which will no doubt further increase the trend.

*Bell Telephones Quarterly, July, 1935.

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Modern Arc Welding

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SUMMARY.—This paper outlines the main considerations affecting the employment of arc welding in steel structures and machine parts. Among the topics treated are the actions occurring in the arc, the selection of equipment for arc welding, the suitability of various types of joint and the precautions to be taken in the design of welded work. Notes are given on residual stress, the training of operators and the inspection of the finished work.

Welding, in its many forms, has become a very important method of joining metals particularly within the last ten years. Despite the widespread use of welding there appears to be more misleading information dispensed in connection with the art than can be fairly excused by reason of its comparative novelty.

A comprehensive treatise on modern welding would be encyclopedic in its proportions and, due to the rapid development of all branches of the art, would be partly obsolete upon completion. This paper will be confined to giving a general résumé of metallic arc welding of mild steel exclusive of all other welding processes. It is not intended to attempt any detailed treatment of design of equipment, joint design, electrodes or methods but merely to outline in a general way the various factors involved in arc welding. It is primarily intended as a guide to those who are faced with the necessity of equipping and operating a shop in which welding will be performed. It is a transcription of notes used by the author in addressing various branches of The Institute during the winter of 1935.

Each of the many other welding processes (such as oxy-acetylene, thermit, electric percussion, electric spot, electric flash, electric resistance, atomic hydrogen and carbon arc) has applications for which it is peculiarly adapted and for which the metallic arc process would not be economical or practicable. Engineers would be well advised to obtain general information on all welding processes.

The metallic arc process, however, is the one which is most widely used in general engineering for the welding of mild steel for buildings, bridges, tanks, machine frames and for repair work in industrial plants, mines and on construction jobs.

Welding is not a new art although modern welding processes have extended the field to which welding is applicable. Forge or smith welding is an ancient art which is in commercial use today in practically its original form. Its application is limited, however, to the welding of simple sections such as rounds, squares and flats although special methods have been developed to allow of its use on longitudinal joints in pipes.

Arc Theory

The properties of the electric arc were first investigated in connection with the arc lamp. This phenomenon of electrical conduction across an apparent air gap in a metallic circuit which is accompanied by the liberation of intense heat is the basis of arc welding.

Arc welding may be defined as that process which utilizes an electric circuit continuously fed with electric current from an adequate source which current is passed through an arc. One pole of the arc is a metallic electrode and the other pole the work. The intense heat of the arc causes the electrode and the work to fuse simultaneously and molten metal from the electrode is added to the work metal to form a welded joint.

There is as yet no full and authoritative explanation of the mechanics of metallic transference in the electric arc. It is known that the bulk of the metal is transferred across the arc into position in the joint by the force of gravity.

Simultaneously there are other forces acting to assist in the transfer of metal across the arc such as the expansive effect of occluded gases in the electrode, the "pinch" effect and, to a degree, electro-magnetic forces in the arc acting on metallic particles of possibly atomic size which are electrostatically charged.

The "pinch" effect is a phenomenon which occurs in plastic or fluid metallic conductors carrying heavy currents. The electro-magnetic forces act to force a small section of the conductor—in this case the end of the electrode at the arc—to assume a spherical shape. These forces then act to repel the globule from the electrode. The force is large in comparison to the mass of the globule and is an important factor in the transfer of metal in the arc.

The relative importance of the forces acting to transfer metal, other than gravity, has not been evaluated and it is believed that their total effect is small.

Once deposited the molten weld metal is held in position in flat welds by gravity and in vertical or overhead welds by surface tension and capillary action.

The welding current crosses the arc partly by metallic conduction and partly by gaseous conduction through the ionization of the air and of metallic materials. Oscillograms of arc welding currents read in conjunction with motion pictures of the arc show that the arc is actually short circuited instantaneously several times per second by globules of molten electrode material. During these periods of short circuit the transfer of current is by metallic conduction. At other times the current flow is entirely by way of the ionized gases in the arc.

The energy of the arc, which is liberated within a very small volume (less than .05 cubic inch), gives rise to extremely high temperatures. These temperatures (over 3,000 degrees C.) are such that the electrode and work fuse simultaneously thus permitting intimate fusion of the added metal with the parent metal.

It was observed when studying the direct current arc lamp that heat distribution was unequal and that the positive carbon fused nearly twice as rapidly as did the negative carbon. Thus in direct current welding there arises the question of polarity. It is the established practice in direct current arc welding with bare electrodes to connect the electrode to the negative terminal of the welding generator and the work to the positive terminal. This practice is based upon the observation of the phenomenon of heat distribution mentioned above and the unequal distribution of heat in the arc is of great assistance in obtaining adequate fusion. By connecting the comparatively heavy "work" to the positive or "hot" pole the fact that the heavier "work" requires a greater quantity of heat to reach fusion temperature than does the lighter electrode is counteracted to a considerable degree. This question of polarity is of prime importance in bare electrode welding as it is not possible to obtain proper fusion or arc stability without using the standard or "straight" polarity described above.

Electrodes

Electrodes are of prime importance in arc welding. Indeed it may be said that it is impossible to obtain good results with inferior electrodes.

There are in current use two main classes of electrode for the welding of mild steel, viz.: bare and flux covered.

Nomenclature is rather loose and vague in connection with electrodes although the trade is agreed that the term "bare electrode" does represent a definite class of material. The confusion arises over the designations to be applied to the various types of flux dipped, lightly coated and heavily coated electrode. The tendency now is to classify the flux dipped or washed electrode along with the bare electrode and the lightly coated and heavily coated together as flux coated electrodes.

A bare electrode is simply a straight 14-inch length of steel wire which is accurately drawn as to size and which is given a very thin coating of "sull," lime, or some other arc stabilizer. These light coatings serve merely to resist rust in storage and to stabilize the arc. It is not possible to weld with a bright finished bare electrode.

A covered electrode is similar, in-so-far as its core of steel is concerned, to the bare electrode but in addition has a coating of flux or gas forming materials, or both, such as when fused in the arc, act to cleanse the weld of impurities, to protect the molten metal with a slag and to protect the metal crossing the arc from atmospheric attack.

An appropriate term has been coined as a general designation for welding with covered electrodes. This term is "shielded arc" welding and hence the covered electrodes are designated as "shielded arc" electrodes. Unfortunately the term was originally coined as a trade name by one particular electrode manufacturer and for a time was usually used in referring to that specific make of electrode. Today, however, the appropriateness of the term is such that it is being applied to all electrodes of that general type.

These coated or heavily covered electrodes are of two types—"universal" or general purpose and "downhand" or groove welding electrodes.

The universal or general purpose electrode is so designed as to permit of vertical and overhead welding while retaining some of the advantages of the more heavily fluxed electrode.

The universal or general purpose electrode produces welds of a tensile strength of from 55,000 to 65,000 pounds per square inch with a ductility of from 15 to 20 per cent elongation in two inches.

The heavily fluxed "downhand" or groove welding electrode is definitely a single purpose electrode designed to make welds in the horizontal or "flat" position only. This limitation in application is due to the fact that the crucible effect obtained at the end of the electrode while welding coupled with the higher currents used with these electrodes gives weld metal of great fluidity. This high degree of fluidity (or temperature) of the molten metal acts in such a way as to prevent the metal being controlled in any other position than the horizontal.

The welds produced by this type of electrode show the following average physical properties:

Tensile strength. . .	60,000-70,000 pounds per square inch.
Ductility.	25-35 per cent elongation in 2 inches.

Electrodes and their metallurgical characteristics are discussed at some length in a paper* which will appear in the December issue of The Journal and this phase of the electrode question will therefore not be treated now.

Before leaving the subject of electrodes, however, it would be well to clear up certain misconceptions. It is generally known that the bare electrode produces welds in many respects inferior to those produced by the covered electrodes. Bare electrode welds have poor resistance to corrosion, low ductility and low impact values. Covered electrode welds have better corrosion resistance than steel plate, have good ductility, high tensile strength and give high impact values.

There remains the factor of cost which is often overlooked due to extravagant claims made by those seeking to sell the various covered electrodes. In Canada, generally, it may be said that the cost of bare electrode welds per pound of metal deposited is from 5 to 15 per cent less than the cost, as deposited, of welds made with the shielded arc electrode.

The engineer may specify bare electrode welds on structures that are not dynamically loaded and where the cost of the welding is an important factor in the total cost. Welding engineers favour the use of the shielded arc process for all work regardless of the cost differential.

Machines and Circuits

The characteristics of arc welding circuits are determined by the characteristics of the arc itself. A high open circuit voltage is required in order to "strike" or start the arc.

The open circuit voltage varies between 50 and 70 volts in machines designed for bare electrode welding and may run as high as 100 volts or more on a.c. transformers or alternators for shielded arc welding.

The arc voltage, as already noted, lies between 18 and 35 volts. Thus the machines and circuits for arc welding must have a comparatively high no load or open circuit voltage coupled with a load voltage of from one third to one half of the no load or open circuit value. In addition, for good welding, the arc current must have a constant average value and this value may be anywhere within the current output range of the unit. The range of current values taken

*The Metallurgy of Metallic Arc Welding of Mild Steel," by C. R. Whittemore, A.M.E.I.C.

from a typical welding generator may well be from 100 to 350 amperes by continuously variable control. From the foregoing it will be seen that generators for arc welding offer a difficult design problem.

Regardless of the inherent stability of the machine proper it is often necessary to incorporate stabilizers in the form of external reactors or special stabilizing windings in the machine in order to obtain the degree of stability and rapid voltage recovery required in the arc circuit.

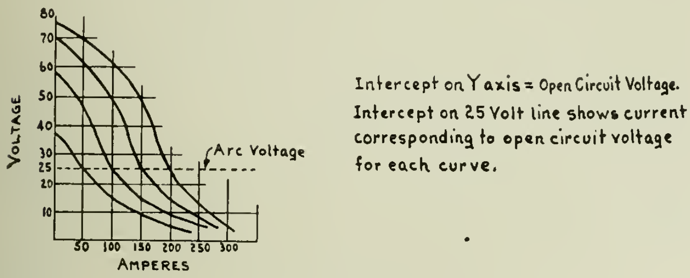

Fig. 1.

Since the arc is short circuited instantaneously several times per second the necessity of rapid voltage recovery characteristics is apparent.

There are two general machine classifications: "Constant Voltage" machines and "Variable Voltage" machines.

Constant Voltage Welding Generators

Machines of the constant voltage type obtain the drooping voltage-load characteristic (see Fig. 1) by means of resistors. Figure 2 shows a schematic diagram of a typical constant voltage type welding equipment.

The generator of a constant voltage type welder is usually designed as flat compound, that is, the generator output voltage is constant over the range from no load to full load. The voltage of the unit is adjusted by the shunt field rheostat to lie between 50 and 75 volts as required. The moment current flows in the external circuit through the electrode and arc the welding rheostat becomes operative and causes the overall circuit characteristics to approximate those shown in Fig. 1. As an example of this assume a typical case:

Electrode size $\frac{3}{16}$ inch, current required 200 amperes, arc voltage 20 volts. The generator open circuit voltage may be assumed as 60 volts. From the data it will be seen 40 volts must be absorbed in the welding rheostat and in the resistance of leads and reactor. Allowing 5 volts drop in leads and reactor leaves 35 volts to be absorbed in the rheostat itself. Suitable adjustment of the rheostat will accomplish the desired result.

It is well to observe that this voltage drop in the rheostat occurs only when current flows and that while the current flows there is a large power loss. In this example the loss is (35 × 200) watts = 7,000 watts. At the same time only (200 × 20) = 4,000 watts is being used in the arc to do useful work. The efficiency of the constant voltage welder is therefore of a low order.

Assuming a conversion efficiency in the motor generator of 80 per cent and knowing the actual welding circuit conditions from the above it is found that (ignoring lead losses):—

$$\text{Efficiency} = \frac{\text{Useful output}}{\text{Total input}} \times 100$$

$$= \frac{4{,}000 \times 100 \times 0.8}{(4{,}000 + 7{,}000)} = 29 \text{ per cent}$$

An overall efficiency of only 30 per cent represents a serious loss of power where power cost is high.

Against this low efficiency must be balanced the lower cost for the machine. Constant voltage welding generators are usually used to serve more than one operator with the welding circuits being connected in parallel. See Fig. 2.

Thus a multiple-operator constant voltage welding generator might be arranged, and often is, to serve ten welders. When this is done the machine of this type is an economical source of welding current particularly for shop use.

It is not uncommon to connect seven welders' outlets to a multiple-operator type machine designed to deliver one thousand amperes and for each welder to use current up to two hundred amperes. This apparent overload is of no consequence since the load factor as between a group of welders is very poor—sometimes as low as 50 per cent.

When this condition obtains and portability is not a prime consideration the low cost per welding outlet of the multiple-operator constant voltage machine is a decided advantage. The cost of equipment per outlet is about half that of single-operator variable voltage type equipment.

Variable Voltage Welding Generators

Variable voltage welding generators are so designed as to obtain the drooping volt-ampere characteristics of Fig. 1 by means of their internal winding arrangement and without the use of external power wasting resistors. These generators are inherently single-operator machines and it is impossible to employ such units to supply welding current to more than one operator.

The single-operator variable voltage welding generators obtain the drooping volt-ampere characteristic of Fig. 1 by means of differential compounding. This method is more economical than the resistance method in that the reduction in voltage from the open circuit value to the welding value is accomplished by demagnetization of the field system which in turn reduces excitation and generated voltage. Machines of this type are very efficient, their overall efficiency including motor being as high as 60 per cent.

Some machines are designed as self excited while others have small exciter generators mounted on the same shaft. The relative merits of the two systems are largely a matter of opinion, the better machines of each type being satisfactory.

Machine Ratings

Rating of welding machines is an important consideration when making a choice between several makes. Most American or Canadian built machines are one hour

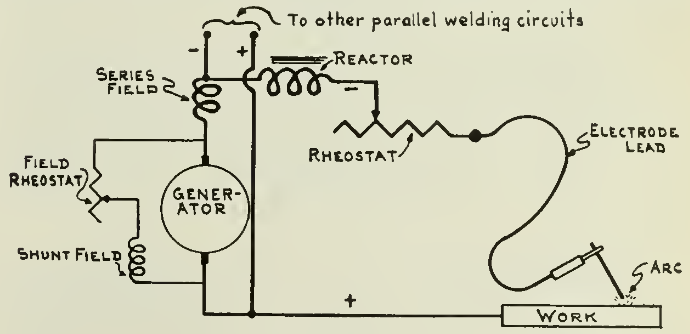

Fig. 2.

rated and built according to National Electric Manufacturers Association standards.

Voltage rating is a point worth attention when purchasing new equipment or when assigning machines to a specific job.

It should be noted by users of welding equipment that the majority of machines now in use are unsuitable for the use of shielded arc electrodes. It is important that machines intended for use with covered electrodes be of 40-volt rating. The older types of machines rated at 25 volts have insufficient capacity for any but the smaller (⅛- and 5/32-inch) covered electrodes and then only those machines which permit adjustment for high open circuit voltages. The common method of rating welding machines is by ampere output, i.e. 200- and 300-ampere machines. The ampere rating alone is insufficient to classify a welding generator and the rated welding voltage should always be given.

This fact will be readily understood when the driving motor sizes of the older 25-volt type and newer 40-volt type machines are compared. The power in the welding circuit of two typical machines delivering the same current will be exemplified as follows:

A 25-volt machine delivering say 300 amperes at 20 volts to a ¼-inch bare electrode has an output of

$$\frac{300 \times 20}{1,000} = 6.0 \text{ kw.}$$

A 40-volt machine delivering 300 amperes at 30 volts to a ¼-inch shielded arc (or covered) electrode has an output of

$$\frac{300 \times 30}{1,000} = 9.0 \text{ kw.}$$

The motor ordinarily applied to a 300-ampere 25-volt generator is 10 h.p. and, while adequate to drive the generator at rated output, cannot drive the generator at the greater rating without overloading and suffering damage. The 300-ampere, 40-volt, generators are normally powered by 20-h.p. motors.

Incidentally the characteristics of the older type 25-volt machines are such that they attempt to keep the arc voltage to the lower values of from 20 to 25 volts and so they are inherently unsuitable for shielded arc welding.

Installation

Installation of welding equipment is a subject worthy of much more attention than is normally given. It should be borne in mind that good welding depends as much upon having a steady dependable power supply to the machines as on any other factor.

The power distribution system to which welding motor generators are connected should be adequate for the load assuming a load factor of 50 per cent for hand welding. All connections should be made in accordance with the regulations of the governing electrical authority and each machine frame thoroughly grounded. If the machines are to be really portable it is advisable to install plug type receptacles on the power distribution system where necessary.

The welding circuit from the generator to the point of welding and back to the generator should be all of extra flexible copper conductor and insulated throughout from ground. The practice of grounding one side of the welding circuit to the steel frame of a building is undesirable from both welding and safety viewpoints and should be discouraged.

Alternating Current Welding

Alternating current has always been used to some extent for arc welding although European practice has been to employ it to a much greater extent than has been the custom on this continent.

One of the reasons for American tardiness in the use of a.c. welding was the widespread use of the bare electrode for welding on this continent until about seven years ago. Alternating current is not suitable for bare electrode welding and thus the development of a.c. welding equipment waited upon the development of the covered electrode. Within the last two or three years this development has proceeded rapidly and a.c. welding equipment of several types is available. It is well to note in passing that European practice involved the use of covered electrodes many years before they became popular in the United States and Canada.

The main advantage, and possibly the only real advantage, of alternating current for welding as compared with direct current lies in the fact that the use of a.c. eliminates the troublesome magnetic effects encountered with d.c.

There are two main types of alternating current welding equipment, viz.: transformer type and high frequency alternator type.

The transformer type is simple and, of course, has no rotating parts and therefore has negligible maintenance costs.

The transformer type of a.c. welder has against it the fact that it is a single phase device and one that generally operates at low power factor. The power factor characteristics of arc welding transformers, however, vary as between the products of different manufacturers. The detailed discussion of this factor is beyond the scope of this paper. Both of these characteristics are objectionable from a plant operating viewpoint.

The high frequency alternator type of a.c. welding equipment has standard three-phase induction motor drive, and thus has characteristics from a distribution system viewpoint similar to those of any standard motor-generator type welding set.

All a.c. welders, however, are inherently comparatively high voltage machines, their open circuit voltage often exceeding 100 volts. The manufacturers minimize this hazard to the welding operator but none the less it is a serious one especially when welding inside tanks or boilers or on high structures. Actually the various manufacturers offer as optional equipment on transformer type welders automatic or semi-automatic control devices which remove the high voltage from the welding circuit either by opening a primary contactor or by reducing secondary voltage afford protection to the operator while changing electrodes.*

Alternating current welding machines, despite some drawbacks, will be used to an ever-increasing extent throughout the welding industry.

Automatic Welding

The term automatic welding is somewhat of a misnomer in that the process is not fully automatic. Automatic welding machines require the attendance of a skilled operator who as well as being a competent welder is also capable of making the many adjustments, electrical and mechanical, required by the apparatus.

Automatic arc welding machines have been in use for about ten years. They are so designed that they strike the arc, move forward along the seam, maintain the arc voltage required and feed the electrode to replace that which has been consumed. They are complicated and costly and their use is only economical where there is a large amount of work of simple form to be welded. Automatic welders have been successfully applied to the welding of small tanks, boilers and pipes. They have never been successfully applied to irregularly shaped parts and the costly nature of jigs and fixtures required limits their use to long runs of similar work

Automatic arc welders have been developed to use the modern flux covered electrode but as yet their success is dubious. Much effort is being expended upon the development of automatic shielded arc welders and there is reason to believe that at an early date the problem will be satisfactorily solved.

Materials

Those steels covered by the Canadian Engineering Standards Association or American Society for Testing Materials Specifications for steel for bridges, buildings, ships, boilers, etc., can all be readily welded. These steels

*"A.C. Arc Welding Transformer and Circuit Characteristics," A. M. Candy, Journal American Welding Society, September 1934

have a tensile range of up to 72,000 pounds per square inch and a carbon range of from 0.12 to 0.30 per cent. The normal manganese range is 0.30 to 0.60 per cent with sulphur and phosphorus not in excess of 0.05 per cent.

With the steels in commercial use ordinarily being kept within the specification limits by modern mill practice the problem of welding is greatly simplified.

It is only with dirty steel or steel containing high sulphur or phosphorus that any difficulty due to parent metal is encountered and that is an extremely rare occurrence. The welding of steels above or below the ordinary carbon range (.10 to .30) offers certain difficulties. The lower carbon steels (below 0.10 per cent), which are not common in industry, are difficult to weld. This difficulty seems largely due to the gas absorption characteristics of the low carbon range. They can be welded to attain full strength but porosity may occur to a troublesome degree.

Steels of greater than 0.30 per cent carbon have been successfully welded using a special technique. It is necessary to employ preheating to about 300 degrees F. while welding and to normalize the finished parts.

The modern low alloy high-strength steels such as chromador, cromansil, etc., can be satisfactorily welded only by employing electrodes designed specifically for the purpose. No modification of welding technique is required, however, and sound welds can be obtained.*

The electric arc may be employed to weld some of the non-ferrous metals but its application to this field is somewhat limited.

Cast iron can be welded with the arc but in the author's opinion the oxy-acetylene process is better adapted for this material.

Joint Design

Very few tools and no machine or structure can be built of one single piece of material. Thus at the outset the designer is faced with the problem of devising connections between the component parts of the structure, machine or vessel.

The ideal joint is one having 100 per cent efficiency, which is perfectly homogeneous in structure and in which there is no break in the continuity of the member or members due to the design or material of the joint. This ideal is one which is unattainable except in isolated cases although modern arc welding provides the most satisfactory means yet devised for obtaining joints in steel that closely approach this standard.

Designers have long been familiar with riveted, pin connected and bolted joints and can predict with complete assurance the performance of any of the three types under a given service condition. This ability to predict performance is based upon results of thousands of investigations of various mechanical (riveted, pinned, bolted) joints extending back over a century of engineering development and of the performance records of hundreds of thousands of structures. While engineers agree that the welded joint is definitely superior in nature to any mechanical joint they have not, as yet, developed confidence in their own ability to design structures employing welded joints. This lack of confidence is not, the author believes, due to their disbelief in the welded joint but solely due to their own caution in using a method of jointing with which they are not thoroughly familiar and upon which there is not, as yet, a wide enough background of experience in service. This natural and wise caution will be readily replaced by enthusiastic adoption of welding as its obvious advantages become more widely appreciated.

With the extended acceptance of welded joints designers will, of necessity, be obliged to give study to the welded joint itself and its mechanical properties such as weld size and arrangement.

The simplest joint possible between two plates or shapes is the butt joint which, when properly designed and executed, can have a very high efficiency.

Figure 3 illustrates the more usual joint types. The single "V" butt joint is the most commonly used although limited, economically, to plates less than half inch thick. In plates of ½ inch or greater thickness the double "V" butt joint is used for economy only and not because of any inherent superiority over the single "V" butt joint.

The "U" groove butt joint has been developed within recent years and is widely used in the butt welding of heavy plates particularly on pressure vessels. It is an economical joint type on plates ⅝ inch and greater in thickness and its economy relative to the double "V" joint becomes more marked in the greater plate thicknesses. The "U" groove type of joint was developed to obtain full advantage of the shielded arc process. Its shape is such that by simple downhand welding in the narrow groove a sound weld is produced.

The partial butt joint illustrated in Fig. 3 is a very common and unsound type. This joint is not truly continuous through the thickness of the section and there will be heavy stress concentration at the roots of the two welds which will raise the stress in those areas to a figure greatly in excess of that assumed as average stress in designing the joint. The total thickness of weld metal when the reinforcements are included is greater than the plate and might therefore lead a careless designer to assume low average stress. The fact remains, however, that a complete joint welded through the full section and having less reinforcement would be not only cheaper but safer and would have no dangerous stress concentration due to lack of continuity. This type of joint is unfortunately too common. While sketched in the figure as having been made in a plate of ⅜ inch in thickness by partial grooving it is often made even in plates of that thickness by simply fusing into the square plate edges from both sides. Such a joint has very porous and dirty metal lying in a seam or pipe through its centre which is, in the author's opinion, simply inviting trouble.

In butt welds the guiding principle is to so prepare the joint as to obtain penetration of weld metal throughout the full plate thickness. On plates of ¼ inch in thickness or less full penetration may be obtained without scarfing or grooving by simply welding from both sides with a quarter inch electrode. On plates of greater thickness the joint should be scarfed either to form a single or double vee joint.

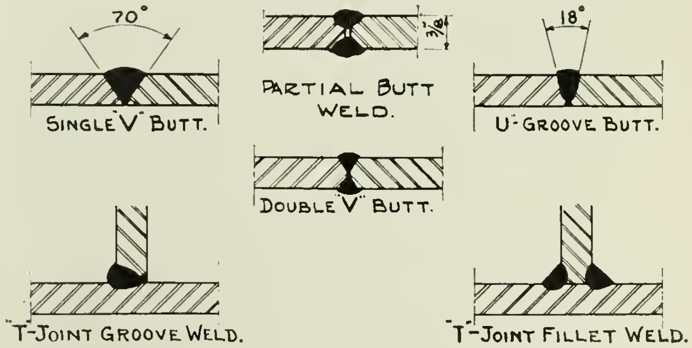

Fig. 3.

On certain classes of work, notably car building, it is common practice to attempt penetration in a butt joint from one side of the plate without grooving. This practice is one which is open to serious question and most welding engineers feel that it should be prohibited.

*"Development and Use of Low Alloy, High Tensile Steel," A. E. Gibson, and "Welding of Low Alloy Steels," J. C. Holmberg, both in Journal of American Welding Society, September 1935.

The most extensive application of the butt joint is to large tanks, pipes and pressure vessels. In this field the welded joint has shown such remarkable savings in cost, reliability and tightness that it is rapidly displacing the riveted joint on all except the smaller pressure vessels.

While the butt joint is the simplest and most efficient joint in-so-far as disposition of metal is concerned nevertheless the most common type of welded joint employs the fillet weld. Indeed about 90 per cent of all welded joints are of the fillet type.

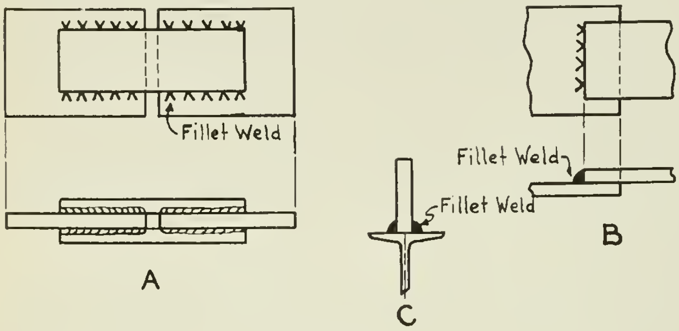

Fig. 4.

Joint "*A*" in Fig. 4 is a very common type of joint. It is simple to fabricate and assemble although not as economical in its use of weld metal as is a plain butt joint. In addition it has the extra material of the splice bars which would be absent in a butt joint.

The lap joint "*B*" is a very common joint in storage tanks where joint efficiency is not a criterion of design. It has severe eccentricity and is never used between members of structures.

The "tee" joint "*C*" is frequently used for details on structural work and is a simple joint to fabricate and weld. It is most frequently used for knee bracing connections to columns and beams.

When considering design of fillet welded joints it is well to so dispose the weld metal around the parts joined as to prevent any tendency to progressive failure due to torsional stresses at the joint. The best example of this point is shown in Fig. 5.

This figure shows a box structure composed of four corner angles and an angle web system in each face. This type of member is encountered in light crane girders, coal bridge structures, transmission towers, crane booms, etc. Note that the welds are placed so as to connect the members together for the figured axial or transverse loadings. These welds however have on some structures shown a tendency to failure when torsion is introduced due to service conditions. The welds fail by tearing progressively and such a structure is unreliable. If, however, the condition is anticipated it can readily be corrected by redistribution of welds. By simply placing part of the total weld required at any intersection at right angles to the remainder, the joint can be stiffened without extra cost of weld metal and a sound and reliable structure be evolved. (See "*X*" in Fig. 5.) In a riveted structure the rivet heads accomplish the same result. Generally these weld failures due to torsion stresses in joints of this type start in craters at the end of welds. It is a fundamental rule that no crater should ever be permitted at the ends of any fillet weld.

If the mechanical nature of the joint is such as to prevent the weld being run partly from each end thus placing the crater in the centre of the length of the weld then the crater should be carefully filled with weld metal. A simple manner of avoiding a crater in the line of a weld is to break the arc on the parent metal out of the line of the weld proper.

Designers in the past have frequently called for single sided or one sided fillet welded "tee" joints.

This joint (Fig. 6) has been a constant source of trouble to welding engineers as it is fundamentally unsound and can be knocked apart with a small hammer. This has often been done and those who witness such a demonstration usually assume that the fault lies in welding as a jointing method whereas the true weakness is one of design. A moment's consideration of the geometry of such a joint will show that there is, as assumed in the sketch, a lever arm of sixteen to one acting when the blow is struck and thus the stress in the root of the weld is much above the ultimate causing failure. Redistribution of the weld metal so as to place half of the total on each side of the plate will resist any attempt to cause failure.

Design precautions may be summarized in six simple headings:—

(1) Place all welds in accessible positions.
(2) Be sparing in the amount of weld specified. Apply only the amount of weld actually required as excess weld metal adds to cost and may even act to give a weaker, not a stronger, joint.
(3) Avoid using fillet welds in tension where the member is liable to encounter torsional stress in addition to pure tension.
(4) Avoid eccentricity just as in riveted work.
(5) Place all welds and joint materials symmetrically if possible. This will limit distortion and residual stress.
(6) Avoid single sided fillet welds or partial butt welds.

Welding Technique or Procedure

Given sound design, suitable materials, electrodes and equipment there still remains the complicated group of interrelated problems of technique and procedure. These problems arise out of the physical nature of the arc welding process—the application of small quantities of molten metal to a comparatively large mass of cold metal. The forces of expansion and contraction set up vary in degree with the relative weight and stiffness of the member, the quantity of weld metal and the rate or speed at which the weld is applied. This variation in relative weight runs from the condition found in small light members with a few small welds in which distortion and stress are negligible to large members of heavy section upon which large quantities of weld metal are deposited.

Welded members and frames must be kept relatively free from distortion and stress and for these reasons an attempt is made to so devise procedures that the stresses due to the process are controlled insofar as their warping action is concerned and limited as to their residual values. One example of correct weld sequence is shown in Fig. 7 and the following description:—

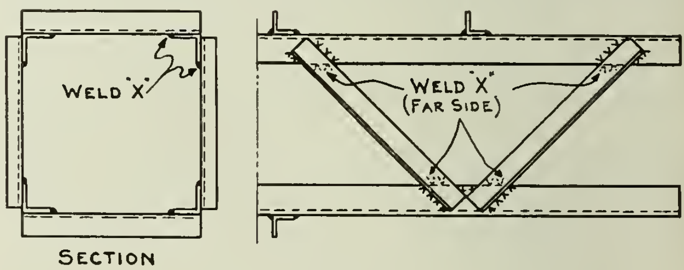

Fig. 5.

(1) In a member such as a plate girder all butt welds or other splices in webs and flanges should be made before the final assembling.
(2) All welds between stiffeners and web should be made either before final assembly or whilst welding the flange plates to the web. If the latter

method is used the welding of the girder should be carried out while lying with the web horizontal and the flanges rigidly guided so as to preclude their deflecting off the square.

The flange welds are started at the centre on both top and bottom flanges. As the welding progresses toward each end along each flange the stiffener welds are made when they are reached.

When all the welds between flanges, web and stiffeners are complete on one side the girder is turned over and the welds on the other side made in a similar way. Such a procedure allows shrinkage to occur freely and there is a minimum of residual stress.

Shrinkages are best evaluated by actual study of a typical joint. The safest procedure to follow if any doubt exists is to make a sample joint and actually evaluate the shrinkage by micrometer measurement. As a general rule the shrinkage in an ordinary section such as a built up beam or girder due to the longitudinal shrinkage of flange to web welds will be in the region of ½ of 1 per cent in length. While not a large percentage it is important if the girder or beam considered is long and has holes for connection purposes at the ends or along its length. When building machine frames or heavy structural details the prime rule is to break the larger and heavier members into sub-assemblies thus obviating cumulative strains. Advantage should be taken where possible of the economies possible when welding in the "flat" position. This involves the exercise of some ingenuity in placing and handling members for welding and in devising fixtures. It will be found possible to obtain a considerable increase in welding speed and more uniformly high quality welds if the work is manipulated into a position, or positions, such that the welder can work straight downhand in what is, in effect, a 90-degree vee formed by the plates at the joint. The speed of deposition in such a "V" will average 20 to 50 per cent higher than when the fillet weld is made in the conventional position with one plate horizontal and one vertical.

Regardless of the procedure or sequence adopted the engineer should carefully watch all heavy and important work while in process with a view to detecting tendency toward distortion and modifying procedure to check or correct the difficulty.

Residual Stresses

Notwithstanding the care used in design and in devising procedures there will still exist residual stresses whose

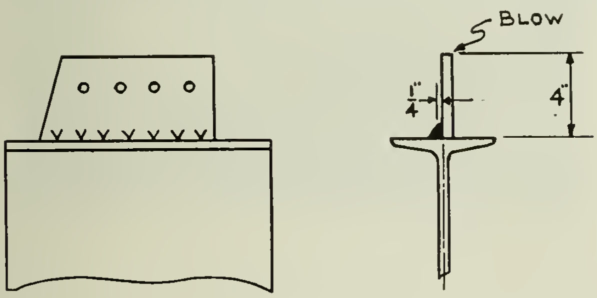

Fig. 6.

magnitude and direction are almost completely indeterminate.

On light work, such as small buildings, where there is considerable structural flexibility; on storage tanks and other very light structures; or on any type of fabrication where the relative amount of weld to the weight of the structure is small, the residual stresses can be disregarded with safety. In the case of large work such as pressure vessels, machine frames and heavy structural details, particularly where subject to dynamic loading, these residual stresses are of a serious nature. The residual stresses act as an unknown degree of pre-loading and therefore must be removed.

Stress Relief

Stresses due to welding in heavy fabrications and pressure vessels may be relieved by heat treatment. This is the only sure method of reducing them to the low values essential to avoid any danger of pre-loading.

Stress relief by heat treatment is accomplished by slow heating of the welded part in a suitable furnace to about

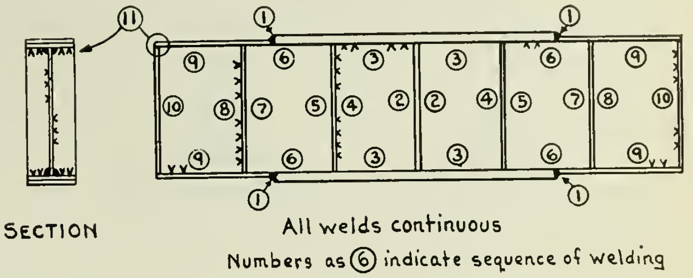

Fig. 7.

1,250 degrees F., soaking at that temperature for a time equal to one hour per inch of thickness of material and slow cooling in the furnace. The relief of the residual stresses is accomplished due to the fact that at the stress relieving temperature of 1,250 degrees F. the yield point of the material is reduced to about 3,000 pounds per square inch and thus any stress existing in excess of this value disappears. This is borne out experimentally and may be readily verified.

As well as removing preloading, stress relief removes the tendency of highly pre-stressed structures toward creep under load in service.

Stress relief by heat treatment is mandatory in the case of many vessels designed for storage of liquids and vapours under pressure. Unfortunately the practice of stress relief has not been carried into other phases of arc welded fabrication and as a result some unfortunate failures have occurred. These failures have not always been actual mechanical breakages but have more often been in the form of warp occurring after the welded part has been placed in service. Welded frames designed to replace castings as component parts of machines or as complete machine frames should be stress relieved after welding is completed and before machining. A properly designed welding which has been carefully stress relieved may be machined and assembled into a machine with the assurance that there will be no further warpage to cause misalignment of parts.

Peening has often been suggested as a means of relieving weld stresses. The difficulty in using peening is to determine how hard to peen and how long and over what areas of weld and parent metal. Peening is useful as a subsidiary method of stress relief on heavy work but is not as yet a sufficiently controllable method to be used for complete relief of weld stresses. While peening is permissible on all weld layers except the top or final layer it is necessary to resort to heat treatment to achieve adequate stress relief of heavy welded frames.

The advantages which accrue from stress relief are two:—

(1) The stress relieving operation alters the physical properties of the weld metal so that the ultimate tensile strength is reduced to about equivalent to that of the parent metal, with shielded arc welds it improves the free bend elongation twenty per cent or better, and most important of all it markedly improves the resistance of the weld

metal to fatigue failure. After stress relief shielded arc welds have physical properties in all respects equal to or better than those of the parent plate.

(2) It produces in a short interval of a few hours the same effect as is obtained by ageing castings to obviate warping.

Stress relief is specified by many designers of welded machine frames for parts of all sizes and weights and it is the author's opinion that the process will eventually become standard practice for all welded parts.

Training of Personnel

All welding should be carried out under the direct supervision of a trained welding engineer. These men are few in number but their numbers must be increased by the training of young engineers in welding. When welding was merely a repair tool any good welder was competent to carry out ordinary work but now that welding is being developed into a large scale production process the technically trained man is indispensable. Therefore the first essential in a large plant employing many welders is a competent welding engineer.

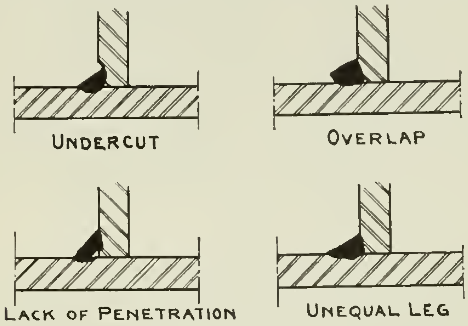

Fig. 8.

A welding engineer should preferably be a civil engineer who has had several years of actual fabricating shop training. He should become a competent welder and be thoroughly familiar with the equipment and processes under his control. He must be patient and resourceful and not afraid of tackling the many perplexing problems that are the routine work of a welding engineer's day.

Welding is a manual art and for best results demands welders possessing a high degree of skill. Such men cannot be picked at random but must be carefully chosen and trained. Due to the nature of the art more responsibility for quality of work is on the welder's shoulders than is the case in many other trades. This indicates that the ideal welder should be trustworthy to a high degree and of such a calm temperament that he can continue to apply himself effectively over long periods to a monotonous and exacting occupation. Welding requires constant application on the part of the welder for a good quality of work.

Training should be of a practical nature, the student taking his place in the shop in an assembling crew and working as a tack welder. As quickly as he develops his skill he should be taught to make welds on actual work rather than be asked to pass long periods of fruitless repetitive practice. During his training period, which should extend over at least one year and preferably two, he should at all times be under the supervision of a competent instructor. This instructor can instill, by example, a pride in good workmanship such that the novice rapidly develops into a true craftsman.

In some plants welders are required to pass qualification tests periodically which are designed to show the man's ability to produce sound welds in any required position. These tests can be very useful in maintaining a high standard of workmanship but should not be employed as a substitute for constant supervision and inspection.

Tests should be made simple and economical in order that they may not be burdensome. It has been the author's experience, and that of many others, that complicated and extensive tensile tests requiring a large expenditure of time and money defeat their own ends by becoming irksome to the production staff and are eventually dropped altogether.

A preliminary qualification test may rightly be comprehensive and include tensile test specimens but all subsequent check tests should consist of simple nick break test specimens which can be quickly and economically performed.

Certain classes of work, such as pressure vessels, are constructed under codes such as the Code for the Fusion Welding of Pressure Vessels formulated by the American Society of Mechanical Engineers and now generally adopted. This code specifies definite tests which must be carried out periodically if the plant in question proposes to fabricate pressure vessels by fusion welding.

Inspection

Many engineers question the susceptibility of welded work to visual inspection without employing destructive tests. It is a fact, however, that a competent welding engineer or inspector is capable of inspecting welding. A good inspector makes a point of observing the welders while they are actually at work and of checking current values and electrode type and size. Having observed the welders at work and being familiar with their test performances the inspector can adequately inspect the finished work by visual methods. Welds which are faulty are readily recognized by their superficial appearance, as is shown in Fig. 8.

Undercut is readily recognizable by the sharp groove in the surface of the vertical plate. This defect can be readily repaired by simply running a further light bead of weld in the groove. While it is a common and dangerous defect it is readily recognized and repaired. The presence of undercut is, however, reassuring as it indicates excellent penetration.

Overlap is a common fault due to incorrect manipulation of the electrode and indicates a possible lack of penetration on that leg of the fillet which is overlapped. The weld should be removed by cutting with a torch or by chipping and rewelded if the overlap is of serious proportions.

Fig. 9—Welded Cable Saddle for Isle of Orleans Bridge. Weight 3,000 pounds.

Lack of penetration is difficult to detect except by using a cutting torch on doubtful welds. The torch flame is directed against the weld surface so as to gouge into the weld with the axis of the flame directed to the root of the weld. By observing the condition at the junction of weld and plate at fusion point the degree of penetration can be determined. When the defect is present it is repaired by increasing the weld size to compensate for the amount by which complete penetration is lacking.

The flat or unequal fillet usually is the result of careless manipulation of the electrode but is not an indication of unsoundness unless the other marks of an unsound weld such as overlap or undercut are also present. If the small side of the fillet is up to the size specified no further work is required. If on the other hand it is undersize it must be built up.

There are other methods of weld inspection such as the electro-magnetic method and the X-ray but neither is applicable to ordinary types of work. The electro-magnetic method is not used in weld inspection in any plant in America to the author's knowledge but X-ray examination is extensively used on pressure vessel welds.

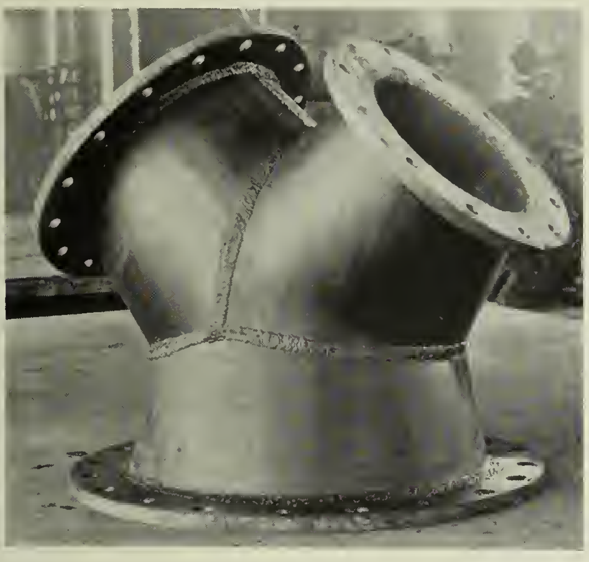

Fig. 10—Welded Pipe Wye, 24 by 16 by 12 inches.

Control

Many individuals in the industry are not fully aware of the importance of adequate supervision in design, fabrication and erection of welded structures.

There exists, as yet, no one authority competent to set up standards of design and workmanship or to adequately supervise the application of such standards in practice. As a result of this absence of control many irresponsible persons undertake to fabricate and erect welded structures, or to repair by arc welding existing structures, who are not competent so to do. They ignore the essentials of sound design and workmanship and employ methods and equipment of types that are obsolete and inadequate. The net result of this is a chaotic condition which cannot but be detrimental to the continued development and application of welding on a sound and proved basis.

The answer to such a condition seems to lie in the institution, co-operatively by those interested, of a governing bureau competent to administer a code of design and fabrication standards for the good of the industry.

Applications

Arc welding as a method of making joints in steel plates and sections has been successfully applied to every type of structure or vessel.

Tanks for the storage of liquids such as oil, water, etc., and hoppers, bins, chutes, etc., are today welded as a matter of general practice. This is due to the simplicity of detail and the tightness of joints possible with arc welding. In most cases in this field the arc welded structure is more economical.

Large storage tanks of greater than 20,000 gallons capacity are usually riveted because of the difficulty of erecting welded tanks in the field when they are shipped in the knocked down form. It is only a question of awaiting development of some method of erection which does not require bolt holes for assembly until even the largest tanks will be of welded construction.

Pressure vessels have been successfully arc welded and welding bids fair to replace riveting in this field. The inherent tightness of the welded joint coupled with the high joint efficiencies obtainable without any special complication have been factors in the rapid adoption of welding in this field. Pressure vessels are in service today under temperatures of from 800 to 1,000 degrees F. and pressures of more than 1,000 pounds per square inch on which all joints are arc welded. Some of these vessels have walls up to four inches in thickness.

From welded boiler drums it was a short step to welded steam headers and branches and several high pressure plants are in operation today in which all piping joints, including those between pipe and fittings such as valves, are arc welded.

Piping of all types is now welded in preference to the use of screwed or flanged fittings with resultant improvement in flow conditions and in freedom from leaks. Most pipe welding is performed by means of the oxy-acetylene process due to its greater flexibility and lower cost on this type of work.

Pressure pipe for water works systems and for penstocks is now being welded in preference to riveting due to the economies possible and the freedom from leaks.

Welding is now being applied successfully to the fabrication of "weldings" replacing steel castings. This is an important field of application and one which is having rapid development. The advantages of the welding over the casting are numerous:—(1) Elimination of patterns. (2) Greater flexibility in design. (3) Rapid deliveries. (4) Freedom from flaws. (5) More economical use of material and consequent reduction in weight. (6) Smaller machining allowances and easier machining due to freedom from sand or hard spots resulting in lower machining costs. (7) Lower cost on large weldings (one ton or greater).

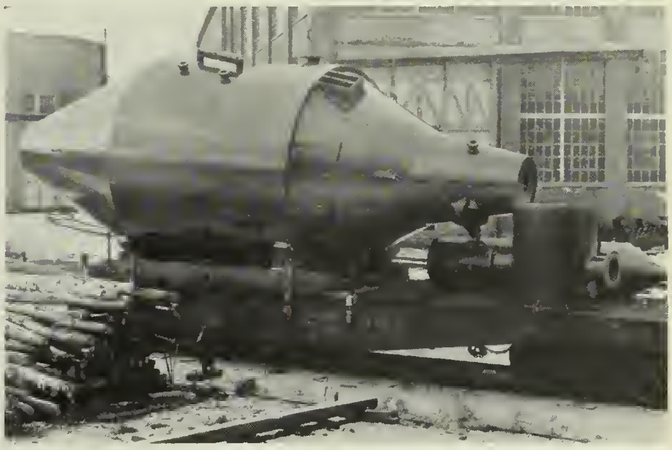

Fig. 11—Welded Salt Evaporator. Length 55 feet, weight 25 tons.

Among the weldings already fabricated are press frames, planer beds, engine frames, gears and many other parts.

The application of arc welding to bridges has, with a few notable exceptions, been restricted to short spans. There is every reason to believe, however, that welding will be applied to an ever greater extent to bridge structures with a consequent reduction in their weight.

Arc welding is being used extensively to reinforce existing bridges and this application is of great importance economically since it will permit older bridges to be reinforced for greater loadings and thus extend their life.

Buildings have been constructed by arc welding in many cities both on this continent and abroad. The welded steel building is lighter and stiffer and the riveting noises usually so objectionable in cities are eliminated when welding is employed.

The illustrations Figs. 9, 10 and 11 show representative types of work that are today being successfully arc welded.

Welding, both by the arc and by other methods, is today not only a useful repair tool but also an effective production process. Its adoption is revolutionizing conceptions of design in all fields and as its advantages become more widely known its applications will multiply. Arc welding indeed marks the beginning of a new age in steel.

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Surveying and its Relation to Property

Particularly as regards conditions obtaining in the Province of Quebec

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, January 24th, 1935.

SUMMARY.—In outlining the functions of the Provincial Land Surveyor, Mr. Lindsay describes the system of land registration in the province of Quebec, and explains the principal legal provisions affecting the surveyor's work. Notes follow on the organization and equipment of survey parties whose work lies in unpopulated areas.

Jean Bourdon was the first surveyor to hold his commission as such in Canada, and he received that from the King of France in 1634. He was a civil engineer, like most of the surveyors who followed in his footsteps down the centuries.

The Corporation of Quebec Land Surveyors was founded in 1882 to weld the scattered members of the profession in this province into one body, to ensure uniformity of method in taking measurements, to maintain the necessary standard of education and experience amongst its members, to provide for the safekeeping of their plans and records for future generations, and above all to protect the public from imposition and fraud by ensuring that all works involving the delimitation of property boundaries should be performed only by properly qualified men subject to disciplinary action. With a few exceptions due to different needs, these reasons were the same as prompted the formation of the Canadian Society of Civil Engineers, some five years later.

It is commonly supposed that surveying consists mostly in running an instrument and using a chain, measuring up a number of lines in a mechanical sort of way and making the necessary calculations to ensure an accurate closure of these. Actually land-surveying goes a great deal deeper than that, it goes into the very foundations of property ownership and property rights. Surveyors originally started out as civil engineers, but specializing as surveyors they have gradually leaned more and more towards the legal profession, until they have become as necessary an adjunct to it as is the notarial profession, though in somewhat lesser degree. Quite a large portion of the practice of a surveyor consists in legal matters pertaining to property, and as such he must be an expert in all matters of law pertaining thereto, and be capable of acting in an advisory capacity to the lawyer or notary engaged in the settlement of any boundary dispute or property transaction whatsoever. As an illustration, you go to a notary to have your deed of sale drawn up and signed, but you go to the surveyor either directly, or through your lawyer or notary, to make sure that the property you are buying is properly described in the deed, that its measurements are correct and that there are no trespasses upon its boundaries.

The surveyor is obliged by law to keep an accurate record of all his operations, plans, field-notes, and other information obtained in the course of his practice, and maintain these properly indexed so that copies may be obtained or the originals consulted at any time. After his death if they are not transferred by his executors to another qualified surveyor they must be deposited with the Prothonotary of the district in which he practised, and thus be available for posterity. This obligation is a most important one for the public, and in daily practice it is a common occurrence to consult these old records and plans.

Notwithstanding the comparatively crude instruments of measurement in existence in the early days as compared with present day standards, it is surprising what good records were made, and many points then mentioned can still be retraced at the present time.

In the province of Quebec, there are two systems of measurement both officially recognized, namely the old French or Paris foot and arpent and the English standard foot and acre. The French arpent and foot are used for computation purposes in the seigneuries and land laid out under the French regime, the actual measurements are made with tapes graduated in English measure.

All measurements in the original seigneuries, which for instance include the whole Island of Montreal, are French measure, unless English measure is expressly stated. It is therefore necessary to remember that unless a dimension in a deed or other document is specifically stated as being English measure the law presumes it is in French measure.

Before proceeding further a definition of property should be given. Property is something which may belong to a person through right of ownership. It may be corporeal or incorporeal, principal and necessary, real or personal. But officially the Civil Code of the Province recognizes only two ways of classifying it, namely moveable and immoveable. Corporeal property is that which has substance such as land or merchandise, while incorporeal property is something which has no physical existence like a share in a commercial enterprise. The main thing to remember is that immoveable property may be taxed or hypothecated but moveable property may not be.

Thus it is important to know just what may be classed as immoveables; to give an instance, the transmission lines of power companies were long considered as being moveables, but not many years ago, a decision was handed down by the Privy Council fixing them as immoveables, and taxable.

A building is considered as consisting of more than its walls and roof. Balconies, gutters, shutters, doors, windows and screens, heating and plumbing systems, etc., are considered as forming part of the immoveable once they have become attached thereto. A boiler placed in a building as one of its constituent parts is an immoveable by nature.

Vegetables, crops, fruit, plants and trees which adhere to the ground are immoveables as long as there is adherence; there are numerous modifications of this and in case of dispute it is advisable to seek legal advice.

Land, the most widely-owned immoveable, is held under either one of two tenures in the province of Quebec, either by franc aleu roturier or in free and common socage. The former is the tenure if the land has once formed part of a seigneury, while the latter is the tenure if the land has been obtained through grant from the Crown subsequent to the cession to Great Britain.

During the French regime, most of the land fronting upon the great rivers had been ceded to seigneurs, who in return bound themselves to develop this land, colonize it and supply a stated amount of military service as and when required. Those whom they brought out to settle upon their seigneuries were called concessionnaires or censitaires and were subject to certain feudal servitudes, not least of which was the payment of an annual rent. These censitaires were never the real owners of their land, but merely held it at the pleasure of the seigneur. It is not generally known, that after the cession, the British Crown continued for a little while the system of conceding land to seigneurs, and during that time the seigneuries of Murray Bay, Mount Murray, Shoolbred, and five others were conceded. This system did not prove popular however, and the remaining lands were divided into townships and conceded direct from the Crown, subject only to certain reserves for mineral rights, etc.

Under the seigneurial tenure the censitaires or tenants were not only liable for feudal or seigneurial duties or charges but their annual rental was perpetual and irredeemable. In the middle of the last century this system was enquired into and it was found to be not only unsatisfactory but unfair and injurious. The first acts for the abolishment of this tenure were passed in 1845 and 1849 but these did not meet with general approval and finally in 1854 another and final act was passed which converted the tenure of land in these seigneuries into free tenure of franc aleu roturier, as follows:—

To quote from Marler's book, "The Law of Real Property":

1. From and after the date of the publication in the Canada Gazette of the deposit of the Schedule prepared by the Commissioners for any seigneury, each censitaire therein held his land in franc aleu roturier, free and clear of all cens, droit de banalité, droit de retrait and other feudal and seigneurial duties and charges whatever, except the redeemable constituted rent fixed by the Schedule, which was substituted for all seigneurial duties and charges.

2. Every seigneur held his domain and the unconceded lands in his seigneury, and all water-powers and real estate belonging to him in franc aleu roturier, and the constituted rents payable to him under the Act by his censitaires, free and clear of all feudal duties or dues to the Crown or to any seigneur dominant of whom his fief or seigneury was then held, and he could deal with his unconceded lands in the same manner as land held by other persons under the same tenure might be dealt with.

3. In order that no tenure resembling feudal tenure should ever be charged on lands, whether held in free and common socage or in franc aleu roturier, it was provided that no such lands should ever be charged with a perpetual and unredeemable rent, and if such a rent had been stipulated its capital might be redeemed at the option of the holder who would pay the capital of the rent calculated at the legal rate of interest, and all other feudal duties and charges or servitudes were declared null and void.

When subdividing the townships the system followed in the province consisted in general of lots of narrow width by considerably greater depths. This system has much to recommend it in a new country, it brings the neighbours closer together, reduces to a minimum the amount of road which has to be built and maintained in summer and winter per unit of population and conduces to a denser settlement on fertile soils. In the first days all lots were made fronting upon the rivers, which were then the main arteries of travel.

Since 1884 all lands sold by the Crown are subject to a reserve of three chains in width on all lands bordering upon non-navigable rivers and lakes, which remain the property of the Crown. In lands sold previous to that date, ownership extended to the centre of the non-navigable stream or lake.

In navigable streams or lakes, ownership extends to high-water mark only. This high-water mark is usually called mean high-water and is generally accepted as being the line of limit of growth of land vegetation and the beginning of aquatic vegetation. Spring floods may extend above high-water mark without affecting its authenticity.

Fig. 1—Typical Surveyor's Post and Stone Mound.

A navigable river is one which is floatable and which may be driven by logs in rafts. A non-navigable river is one which may be driven only by loose logs.

Another important point involving property is possession. That old saying that possession is nine points of the law is not far out, in this province at any rate. Possession is defined as the keeping of something in our power either by oneself or by someone holding it for us and in our name, with the intention of holding it as owner.

If a person occupy a piece of property continuously and uninterruptedly, publicly, unequivocally and as proprietor for thirty years he has fulfilled all the requirements of prescription and as such is entitled to possession. From this it follows that if a wall, or a fence, or some other mark of that nature such as a line of blazed trees through the bush, be accepted by two neighbouring proprietors for this period without question or dispute, then this wall or fence or line of blazed trees is their boundary-line, whether it be straight or crooked or in its correct position or not with regard to the original land lines. The law presumes good faith on the part of the occupant, and any claimants to the land occupied must prove the contrary. It will be considered at first sight that this law is all in favour of the squatter. While this is true to some extent it is offset by the fact that every proprietor must protect his own interests by maintaining and correctly establishing his boundaries. This protects the innocent person who may possibly have a flaw in his title through error or discrepancy in description and would otherwise be unjustly evicted.

Originally the term "squatters' rights" was meant to apply to the settler who had pushed out beyond the surveyed areas in his search for good land, and having found it and settled upon it, was improving his holdings. When the surveyor subsequently came along, it was his duty to take note of the area occupied by each squatter, and in his report give each one credit for what he had. The squatter then had first right to file upon that particular area which he was occupying when the district was thrown open for settlement. As no one can prescribe against the Crown, the squatter has no legal right to his land until the Crown has it surveyed or he has it surveyed for himself and files an application for its purchase.

As already stated one cannot prescribe against the Crown, nor can one prescribe against property possessed for the general use of the public such as roads, squares, landing places, etc. Property belonging to municipalities for other uses than the above is subject to prescription.

Land titles in the province of Quebec are recorded by the cadastre system, and all transactions are registered in the Registry Office of the district concerned. By this means the identity of a piece of property is maintained no matter how often it is subdivided or redivided or changes hands. The method used is simple; it consists of hyphenating the numbers of subsequent subdivisions with the number of the original lot in any municipality. When a portion of the country becomes thickly settled and transactions are taking place between the settlers involving portions of lots on the original survey, the provincial government has a cadastral plan made of the township, in which each man's holdings are measured and a book of reference is prepared showing the owner of each piece of land in the township, taken separately, its boundaries upon all its sides, and its dimensions and area. It is given, at the same time, a number which would be a subsidiary number to that given to the lot of which it formed part at the time of the primitive survey. This cadastral plan and book of reference are prepared in triplicate, submitted to the Minister of Colonization, Game and Fisheries for his approval, during which time official notice is given to the public in general, but especially to the inhabitants of this township, that this cadastre has been prepared and that it may be examined at an appointed place, generally the principal town or village in the community, and after all objections, if any, are straightened out, it is formally accepted and comes into force. The original is kept in the archives of the department at Quebec, and a duplicate copy, duly certified, is sent to the Registrar of the district concerned.

Subsequently as the community grows in size, and people gradually group themselves together into towns and villages, it is necessary to make further subdivisions of the lots in these districts. This is done by laying out the boundaries of the lot which it is desired to cut up into building lots and put upon the market, and then designing the same in accordance with the needs of the situation. Unfortunately, the surveyor is not the final dictator of the form which this subdivision is to take, but the proprietor is, and in many cases he wants to get the greatest number of building lots with a minimum of streets and lanes. No streets, in a town or village, can be put in less than sixty-six feet in width unless with the permission of the Lieutenant-Governor in Council.

Engineers frequently express surprise that measurements in a city block do not always conform to what is given for its width or length in the official cadastre. This most frequently is not faulty measurement at the time of the original lay-out, though it sometimes is. In our province there is an article in the Civil Code which specifies that when a man sells a specified area of land he must deliver that exact quantity, and the purchaser may insist upon the exact fulfilment of the contract. Though most deeds of sale are for a determinate thing, and the quantity is qualified by the words more or less, or as it exists at the present time without warranty as to exact content, some are still made stating the actual quantity and the price per unit. If the seller does not have that much land in his lot then he must get out and get the difference from his neighbours. Therefore people who laid out these lots at a time when land was comparatively cheap, were instructed to chain long and leave a surplus in each subdivision so that the vendor would always be upon the safe side.

It must be remembered in deeds of sale that all obscurities are generally construed against the seller, as he is supposed to know better than the purchaser what he has for sale.

Ownership of the soil carries with it the ownership of what is above and below the surface. In the original grants from the Crown prior to 1880 mining rights except for gold and silver were not reserved to the Crown. Since that time all mining rights in all sales of land by the Crown are reserved. Therefore if a prospector discovers a body of ore upon private property he may stake this area under the Quebec Mining Act and mine it; he must however make arrangements with the proprietor of the surface for whatever part of this surface which he shall need. In cases of disagreement as to the value of the land thus taken, the dispute may be submitted to arbitration as provided in the Act. This does not apply to tunnels for transportation purposes, therefore if any such construction is projected it is necessary to acquire right by title from the owner of the surface rights.

In the same way no one can encroach upon the aerial space over another's land by building the eaves of his house in such a way as to permit water to run therefrom upon his neighbours' land, nor have the branches of his trees project thereon. Also any wires or clothes-lines stretched across another person's land may be considered as an encroachment. The passage of an aeroplane would not be, as it is not of a permanent nature.

Land fronting upon running water is subject to increase or decrease in area due to alluvion and erosion respectively. Alluvion is silt carried down by the stream and gradually depositing itself upon the bank through eddies or fluctuations in the current of the river; it becomes the property of the adjacent proprietor. Erosion on the other hand may cut off portions of riparian land and carry it away and deposit it on neighbouring land, to the profit of the owner thereof. If this erosion is gradual the original owner of the land thus washed away cannot recover it but he naturally can endeavour to protect his land as best he may by rip-rap or retaining walls. If this erosion is sudden and caused by a flood or some such agency, and a large and distinguishable portion of land is carried away and deposited upon another property, the owner of the land thus despoiled may have it carried back again to its original site. This is applicable to places where the flood has washed out a portion of a farm down to gravel and boulders and the devastated area has to be back-filled again.

Islands in a navigable stream belong to the Crown, and may be sold or transferred by it. If a piece of riparian property is cut off from the main land so as to form an island, this island still belongs to its former owner. Should an island form in a navigable river through gathering of silt and changing of channels, etc., this island belongs to the Crown and may be disposed of solely by it.

In non-navigable streams, the islands belong to the proprietor of that side of the stream to which it is nearest, provided it is altogether upon one side of the centre line of this stream. If the centre line of this stream cuts through this island, then the two portions of it belong to the riparian owners on each side in accordance with their location.

In the same way, if a non-navigable stream abandons its bed and cuts a new path for itself, the old bed belongs to the proprietor through whose land it has cut its path. In a navigable river the old bed belongs to the Crown and so does the new bed which it has cut.

If a proprietor wishes to construct a dam across a non-navigable stream he must obtain the permission of the proprietor upon the opposite bank. Also no person may take the water away from a non-navigable stream nor interfere with its flow without the permission of the proprietors below him. The Civil Code states that the owner of property through which the stream runs may make use of the water which thus passes through his land for his own use and that of his stock but may not divert any part of its flow to other places or purposes.

A source of interest to engineers in this province is the existence of the mitoyen or common wall between buildings. A proprietor may build a wall altogether upon his own property following along his dividing line. This is a private wall and his neighbour cannot make use of it in any way. He may not lean a building against it, nor train vines upon it, nor even pile earth against it. However the Civil Code states in Article 517 that the adjoining proprietor has the privilege of making the private wall mitoyen in whole or in part, by paying for half of the value of the land of the ground on which it is built plus half the value of the part of the wall which he wishes to render common. It is however recognized that a proprietor may take not more than nine inches of his neighbour's land and construct a wall which would be partly upon his neighbour's land and partly upon his. The neighbour may acquire mitoyenneté in this wall by paying for half of its value, and incorporate it as part of the building which he intends to erect upon his property, but until the transaction involving his payment of his share of the cost of this wall is completed the builder of this wall is absolute owner of it and has the same rights in it as for a private wall. There are various signs used by builders and architects to denote whether a wall is mitoyen or not, and these are as familiar to these professions as to surveyors. These signs are not necessarily final proof however and give way in law before definite evidence to the contrary.

Any proprietor, in a city or town, may oblige his neighbour to share the cost of erection of a fence-wall, ten feet high and eighteen inches thick, between their respective properties. Fortunately for the public this privilege is rarely used, and has never been done so far to our knowledge.

One proprietor cannot make any openings of any kind whatsoever in the mitoyen wall without the consent of his neighbour, not even if these openings are closed with fixed glass and iron grilles. If, however, the city demolishes a house in order to pass a street through the site it occupies, the proprietor of the other portion of this house may make openings in the mitoyen wall in order to permit views out upon the newly opened street.

If a proprietor wishes to raise the common wall he may do so, provided he notifies his neighbour of his intention, and obtains his consent. If the latter refuses the dispute can be settled by arbitration and by experts who

Fig. 2—Cutting Sled Trail around Open Water-course.

determine whether the existing wall is capable of carrying the extra load. If it is not, it must be strengthened by additional supports or thickening placed upon the side of the one who wants to raise it, and he must give the land necessary for this purpose. He must also pay not only all the cost of the erection of this additional height but must also pay to the neighbouring proprietor a sum equal to one-sixth of the value of the new construction as indemnity for the additional load which the common wall must bear.

If the neighbouring proprietor wants to make use of this structure thus erected he must pay half the value of it plus half the value of the land used by the man who raised the superstructure for the additional thickness required.

It frequently occurs, that the examination of the experts reveals that the mitoyen wall as it is built will not stand the additional load designed for it. In this case it must be demolished and rebuilt and during the course of this operation temporary protection works must be put in to support the floors and remaining walls of the buildings. As previously mentioned, if the foundations have to be widened or thickened to carry the additional weight, then the area required must be taken off the land of that proprietor who desired to raise the wall.

Fixing a Boundary or Making a Bornage

Any proprietor may oblige his neighbour to fix the boundary between their contiguous properties. This is a right and the neighbour may not refuse. When the line has never been established or is no longer visible both parties should agree upon a surveyor to establish it for them in accordance with their titles. The costs of the "bornage" are always equally divided but if one proprietor refuses to be called en bornage amicably then an action has to be taken to compel him to do so. The payment of the costs of this action is at the discretion of the court. It is part of the surveyor's role to settle boundary disputes, and he is frequently called upon to arbitrate between rival claimants, generally being both judge and jury.

If the two parties have agreed upon a surveyor, the latter notifies them to be at a certain place near the job, at a certain time, and to bring all documents showing their titles to their holdings with them, and proceeds to draw the line in accordance with these.

If the two parties have not agreed upon a surveyor, then the party desiring the bornage chooses his own surveyor and instructs him to proceed with the necessary formalities to carry out this task. The surveyor then gives the other proprietor official notification to be at a definitely appointed rendezvous nearby at a certain date and time, bringing with him all documents showing his title to the adjoining property, advising him also that he has the right to choose his own surveyor to represent him for the purpose mentioned. These notices must allow three clear days when the domicile of the party concerned does not exceed fifty miles from the property to be bounded, and an additional day for each additional fifty miles therefrom.

If the neighbour refuses to agree to the one surveyor, or to name a surveyor of his own, or does not appear upon the scene at the date and hour specified, then the boundary can only be determined by an action en bornage in the courts. If the neighbour attends upon the ground after having agreed to accept the services of the surveyor suggested by the other party and finds that the line is not drawn in accordance with his liking, he is not obliged to accept it, but may have recourse to the courts.

If the case goes to the courts, the judge appoints one or more surveyors, according to the representations of counsel for the contending parties, as experts to determine the proper position of the line. They are sworn in especially as such. The experts are instructed by the court to make a plan of the locality showing the claims of the various parties, their occupation, and all topographical or other features which may be pertinent to the case.

These expert surveyors proceed in the same manner as if they were working upon an ordinary bornage. They give the usual official notification to the interested parties, examine all the titles, swear in witnesses and take down their testimony regarding the length of time the claimants have been in occupation of their respective areas, etc. The plan is then prepared and filed with the court accompanied by a report, both of which are signed by the surveyor or surveyors thus appointed.

In the cities where land is valuable extreme care must be exercised and measurements taken with great accuracy. However, one is assisted to a great extent by occupational rights and previous notes of surveys in that vicinity.

In the country, especially in the district north of Montreal, the old survey lines have completely disappeared where they have not been maintained by farm-fences, and must be retraced from the notes of the primitive survey. These surveys were made about seventy-five or eighty years ago, with compass and link chains, and the lines are far from straight. However, when one considers the difficulties which these old surveyors encountered, it is surprising that the results obtained were as good as they were. There is considerable local attraction in spots and the compass lines were affected accordingly, but frequent observations with the primitive theodolites used served to keep them fairly well in the right direction. The younger generation are at times disposed to criticize the work of these men harshly, in view of the results which can be obtained with modern instruments. One thing they did excel in and that is their chainage notes. As a rule these were taken with painstaking care and described every important topographical feature clearly and well. It is due to these chainage notes that one is able to retrace these old lines to-day.

As mentioned previously, when an old survey line has disappeared or is no longer visible it must be retraced in its old position. It is not sufficient to measure off the theoretical depth of a range from one that has previously been found, and call the line which would be drawn from the point thus found, the true position of the range-line wanted. The law demands that each line must be retraced in its previous position, and that means that the old survey notes must be obtained and the old line found. If two points are found on the old line a certain distance apart, they may be joined together and the line thus drawn called the proper location of the line, but experience and practice determines with how much latitude the words "certain distance apart" can be taken.

Servitudes

No discussion of property would be complete without mentioning servitudes. Servitude is defined by Marler as being a charge imposed on one real estate for the benefit of another belonging to a different proprietor. That land of which the servitude is in favour is called the dominant land, that land which is subject to the servitude is called the servient land. These separate pieces of land must have separate owners.

Any reserve which is made in the sale of a piece of property can be classed as being a servitude unless it is of a temporary nature. For example, a right of passage, or a right to draw water from a well, or a right to take gravel from a borrow-pit, or the right to cut timber, are all servitudes upon that property where these things exist.

Lower lands are subject to the waters which may flow upon them from higher lands so long as this flow is not increased by the hand of man. This means that these low lands are servient to the high lands to this extent. But the proprietor of the high land cannot drain out a swamp or lake or other body of water upon his land and dump it upon the proprietor of the low land, without compensation or agreement.

Although it has been mentioned previously that the riparian proprietor of any stream cannot divert the flow of this stream, yet there is a special reservation made in the case of springs. A spring is the absolute property of the person who owns the land where it exists and he can dispose of its flow as he sees fit.

There is another servitude which exists upon all riparian property whether this be fronting upon a navigable or a non-navigable stream, and that is the "chemin de halage" or towpath. At one time in the French regime there was a reserve of two French perches in width along both sides of the St. Lawrence river which was to serve for navigation by barge or floating of logs and rafts, and also for vehicles and cattle. This was subsequently abrogated and at the present time, all water-courses whether navigable or non-navigable, lakes, ponds, streams, and islands in navigable rivers are subjected to a servitude whereby the bed and banks of all these may be used for the floating of lumber and for the passage of ferries, boats and canoes engaged in navigation, subject to the repair of any damages which may be caused through these operations. The servitude does not exist for any other purpose however, and does not mean that picnic parties or campers or tourists travelling by canoe can make use of private property without trespassing thereon. It is a very important servitude for lumber companies who have to drive their logs down stream from the piling-grounds to the mills.

In this connection attention should be drawn to the fact that since the limit of private property fronting upon a navigable river is fixed as being at mean high water mark, the beach and low water area extending below that belongs to the Crown. Therefore if any riparian proprietor wishes to build a wharf extending out into the stream it is up to him to secure his possession to the land which he intends to build upon, as well as the beach in front of his residence, by applying to the provincial government for what is called a beach and deep-water lot. These beach and deep-water lots are granted on lease upon presentation of a plan and description prepared by a land-surveyor describing its exact extent and location. The rentals are nominal and the possession of such a beach-lot confirms the land-owner in his possession of the beach between high and low water marks and enables him to protect himself from unwelcome intrusion by the public who use the beach as a highway.

There is another servitude which is of particular interest to residents of the cities and that is the right of view over another's property. According to the Civil Code no proprietor may have windows directly overlooking his neighbour's property unless they are at a distance of six French feet from the mutual dividing line, or 6 feet 4¾ inches English measure. Oblique views from side windows must be at a minimum distance of two feet French measure. The right to put windows or views at a lesser distance than the above has a commercial value, and the proprietor of the neighbouring property may dispose of this as he sees fit, though if he grants this privilege he may diminish the value of his own property.

Lights may be established in a wall fronting over a neighbour's property under certain specified conditions. If these are on the first floor of the building they must be situated at a minimum distance of nine feet from the ground; and not lower than seven feet from the floor if on the upper storeys. These lights must be composed of fixed glass (verre dormant) and provided with an iron grating or grille of not less than four inches between the bars. Moreover these windows must be fastened securely with plaster or cement so that they may not be opened.

A proprietor whose land is enclosed on all sides by that of others and has no outlet upon the public highway, may demand a right of passage over that of his neighbours for the use of his property, subject to an indemnity which would be proportional to the damage which he may cause. This right of passage should usually be taken at that point which is nearest to the public highway; on the other hand it should be taken at that place which would cause the least damage to the land thus traversed. If this land becomes enclosed as a result of a sale, or of a partition or of a legacy, then it is up to the vendor, the co-partitioner or the testator to offer a way out, and not to the proprietor of the shortest possible route, and this without indemnity. If the passage thus given is no longer required, the right to it can be suppressed and the indemnity is refunded or the annual rental ceases to exist.

Servitudes may be extinguished and a servitude ceases to exist when the things subject to them are in such a condition that it can no longer be exercised. It revives when conditions are re-established so it may be used again. If the dominant land and the servient land are united in the same ownership then the servitude of one to the other is extinguished. If a servitude is not used for thirty years it can become extinguished if between persons of full age and privileged. Thus if there is a right of passage over a property, and the proprietor of that property erects a gate or fence which prevents passing thereon, and no objection is made for over thirty years, then the right no longer exists. It is sufficient to perform some public act every once in a while before witnesses whereby the right of passage is exercised, to break any prescription which may have formed up to that time. Any owner of a servitude must exercise vigilance to see that his rights are not curtailed by obstructions, either through his own acts or those of the proprietor of the servient land, otherwise if the curtailed condition exists for thirty years, his servitude becomes limited to this curtailed condition.

Trespass

Before there can be trespass the boundaries of land must have been established and be visible. In settled districts a fence or a wall or a hedge or a line of shrubbery are the most usual signs of ownership and occupation, though a sign or placard placed upon the side of a path or roadway is of the same effect. In unsettled districts where the properties have not yet reached the fencing stage, a surveyor's line well-blazed is easily found and recognized as such by the rural population and woodsmen.

The boundary-line between contiguous timber-limits is marked by blazed trees on each side of the line, the line itself being well cut-out to a minimum width of three feet. It cannot be recommended too strongly that efforts should be made in logging operations to preserve as many of these blazed trees as possible so as to maintain the boundary line. The corners and deflection points are marked by large wooden posts with an iron post alongside it driven deep into the ground, and wooden posts are placed at every mile along the sections of the line.

Of recent years most of the timber-limits of this province have been sold bounded by the height of land of the watershed in which they are located. In the old days limits were frequently sold as being so many miles in depth along the frontage of such and such a river. In rough country it was frequently found uneconomical to log out that portion of the limits thus obtained which were found to be on the reserve side of the adjoining watershed, as all the wood therein would have to be hauled back over the divide.

In obtaining land in unsurveyed townships, the procedure is to call in a surveyor and have him lay off the area required, prepare a plan and description and get it filed with the Department of Lands and Forests, Quebec. In the olden days it was possible to obtain letters-patent to pieces of land of this nature without any difficulty; now it is not usual to sell the land but to grant it on long lease at a nominal sum. Later when the area becomes part of a surveyed township, this area would become part of a numbered lot and it would be possible for the lessee to change his status by filing on the whole lot and obtaining letters-patent. In the meantime his buildings and other improvements are fully protected by the lease.

Mortgages

Mortgages are registered against the lot number affected, in the registry office of the district concerned. Usually a subdivision plan is prepared of the original lot before building lots are put upon the market and this subdivision is registered. In the smaller towns and rural districts regular subdivisions are not always made and lots are sold off piecemeal in accordance with the demand. Therefore any mortgages given to the various proprietors or occasioned by the unpaid balance of the purchase price are registered against this cadastral number as a whole. The description of the land involved is frequently vague, ambiguous, and sketchy, and as the number of transactions increases the registrar finds himself in a position where he cannot commit himself in his Certificate of Search and there is a cloud upon all the properties in the original lot. This cloud can only be dispelled by diligent title examination and subsequent survey. In view of this it is now general practice for a purchaser to insist upon a new subdivision plan being made of the land which he is about to buy so that he may start his occupation with a clean sheet, where this state of affairs exists.

Survey Work in Remote Areas

The surveyor's work in the open is somewhat different from an engineer's. As a rule an engineer comes into the picture when a district has developed enough to permit of solid construction and subsequent advancement. When he goes off into the bush his task consists of a more intensive study of a project, which permits him to spend a longer time in one area for the purpose of concentrating on the information which he is seeking. He has less moving about to do, fewer caches to establish, and is able to erect camps or make himself more comfortable in view of his longer stay and also carry a larger and more varied amount of provisions.

The surveyor on the other hand is still an explorer as well as a surveyor. The surveyor's lines take him anywhere across country where even Indian guides are not totally reliable. This means that personal clothing and paraphernalia must be cut down to a minimum, that food must be rationed to avoid catastrophe, that caches must be built up beyond the reach of depredatory animals, and protected against the elements and destruction by bush fire.

Fig. 3—Well Balanced Portage Train of Men and Dogs.

In cases like these the welfare of men and animals is of the first consideration, and it is well to take upon such a trip only those who have proved themselves capable under similar conditions on previous occasions. The author has found the labouring men best suited for this work are those from the Lower Saguenay, the north shore of the St. Lawrence and Gaspé. The people in those regions are accustomed to hardship, have not yet been spoiled by contact with softening civilization, are exceedingly clever with their hands, are good canoemen and inured to snowshoes and hauling of supplies on sleigh and toboggan. It is not unusual even at the present time to have to plan on expeditions lasting many months.

It must be remembered that parties going off into the hinterland on expeditions must rely altogether upon their own resources. They are complete units in themselves, the regions they will work in are exceedingly remote and difficult of access, and therefore they must look out for themselves.

In the old days, game was plentiful and could be relied on to a considerable extent, but forest fires and indiscriminate hunting have thinned out game and one must plan for all eventualities. A food consumption of 3½ pounds per day per man, of dry, uncooked food is the usual amount. This ration covers meat, flour, dried fruits and vegetables and groceries. Canned goods are avoided owing to the lost weight in the cans and the difficulty in packing. Personal baggage in winter is cut to a maximum of thirty pounds per man exclusive of sleeping gear. Blankets are replaced by sleeping bags and much poundage is gained by this change. Tents are made of silk, and small sheet iron stoves are used. The heaviest item is the cook-stove, but recent improvements in these have permitted the reduction of considerable weight. Now it is possible to get a well-built little stove, with an oven suitable for baking, measuring just the width of a dog-sled, and weighing not more than forty-five pounds.

In the old days, the route into the northern regions was up the great rivers from the end of steel or river-steamboat travel, carrying supplies in canoes in summer, packing them over the portages or lining the loaded craft up through the rapids wheu the banks permitted. This was pretty hard work and progress was slow. If the expedition was for a long period, there would be two men per canoe loaded with close to 1,000 pounds of supplies and baggage.

In the winter the same routes would be followed, sleds replacing the canoes, supplemented by dog-teams bringing up reserve supplies. Since the food expenditure of a party numbering ten men and ten dogs could be based on a daily ration of 3½ pounds each for the men, and 1½ pounds each for the dogs, daily food expenditure would run a total of forty-five pounds per day, it is only a question of arithmetic to figure out the necessary tonnage of food-stuffs required for a trip of several months. It is interesting to know that a man on snowshoes, breaking trail for himself and hauling a sleigh or toboggan, can only convey enough food and baggage to keep himself warmed and fed for a little over one week. Therefore if man is to survive and maintain his energy, it is necessary to organize supplementary means of transportation for the additional supplies required for his stay in the country. These supplementary systems of transportation are the canoe, the dog-sled and the aeroplane.

The coming of the aeroplane simplified matters very greatly. It changed the whole system of communication and transportation and it was a surveyor, Henri Bélanger, of Quebec City, who was the first in this province to organize the transportation of men and supplies into the faraway regions by the use of the aeroplane. Working in conjunction with the late Harry Quigley in 1919 and 1920, they took in all the crews necessary for the survey of the height of land between the Hamilton river and the St. Lawrence in Ungava, which survey was afterwards used for the case submitted by the province of Quebec against Newfoundland for the delimitation of the Labrador boundary. It used to take his men forty-five days travelling by the water route from Quebec via Seven Islands to the site of his work, and the food expenditure during this period made serious inroads in his caches. It was estimated that food landed on the job cost $1.10 a pound, so that a 100-pound sack of flour cost exactly one hundred and ten dollars in addition to its purchase price, before it could be used. By using planes, the journey was made in a few hours from Clarke City or Seven Islands, and caches were made all along the projected route of the work, thus avoiding the re-handling and re-transportation of the supplies from the central cache to the secondary ones.

No article on the outdoors would be complete without mentioning man's good friend the dog. The reasons which make the dog eminently suitable for hauling purposes are that a dog eats the same kind of food as man, and therefore rations for the one are reserve rations for the other; a dog for his weight has a comparatively light tread and can keep a good footing upon a snowshoe trail broken the day before; he does not sweat through his coat and therefore runs no risk of catching cold at the end of the day's travel when he is put into temporary quarters; he has a warm furry coat and when curled up in the den which the dog-man makes for him, blizzards may blow snow several inches over him without making him uncomfortable; and lastly and most important, he is a regular dynamo of energy, a dog can haul twice his own weight with a light sleigh on a well-beaten trail and being intelligent learns to handle his load with almost human care.

In the Arctic regions and along the north shore of the St. Lawrence, dogs are driven in teams of five or more, each one hitched separately by a single trace to the komatik or sled, and as the load gets under way they spread out fanwise and can maintain a good pace for a long time. The conditions there are different from ours however, as almost constant wind packs the snow into hard ridges and affords hard footing without trail breaking being necessary unless after a blizzard. Moreover dog food in the shape of fish, seal or other meat is available and it is possible to support a larger string upon the country. In the northwest, dogs are hitched in tandem, the usual team numbering five dogs, and it is not uncommon for teams thus arranged to make very wonderful runs for distance and time over good trails.

In this province, conditions are different as there is usually rough wooded country to traverse. The snow falls in large quantities and is very soft, lying unpacked through the winter until the warm suns of March put a crust upon it. It is therefore necessary to break trail with snowshoes for every foot of the way, and consequently the pace of the whole party is cut down to the pace of the man breaking trail. This procedure is extremely arduous when snow conditions are bad, and he has to be relieved every few hundred yards. Under these conditions ten or fifteen miles per day is a good day's travel, and when there is a large supply of provisions to be brought up it may average less than that.

From experience the author has found it better to hitch only one dog, or under rare occasions two in tandem, to a sled and this sled is usually loaded with 150 pounds. There are many advantages in using only one dog: If one dog hauls 150 pounds it does not follow that two dogs will haul three hundred pounds, as usually two dogs will only haul about 250 pounds. When two dogs are hitched in tandem in rough country, the lead-dog's pulling has either a tendency to lift the wheel-dog off his feet or to increase the load on the wheeler's back by dragging him down towards the ground; both occasions reduce the leader's pull and increase the wheeler's load; again it is difficult to get two dogs with the same temperament to team together, and anyone who has ever known the term "soldiering" should see how some lead-dogs will just pull enough to keep the traces tight and not an ounce more; if you reverse the dogs and put the energetic wheeler in as leader he will keep up his good work until he falls down exhausted, as now he has to pull his erstwhile leader as well as the whole load.

When a dog is hitched separately to a sleigh he cannot fight; when he is in tandem he often does. When dogs are hitched tandem, it practically requires one man per sleigh, whereas when they are hitched singly, the dogman and one assistant can handle sixteen or seventeen different sleighs with their dogs, and thus leave the balance of the men available for hauling a sled themselves. If you have a party of ten men travelling with ten dogs for a distance of one hundred and fifty miles or so from railhead. you will have a pilot party on in front breaking trail one day ahead of the main body; this party consists of three men, two of them taking turns breaking trail and the third man hauling a light sleigh loaded with their camping equipment and food for a week. Of the seven men remaining with the main body, two of them will be driving and looking after the dogs, helping them over the rough places and keeping them up to the mark, they will be assisted by the cook. The remaining four men will be each hauling sleighs. Allowing 100 pounds per man on each of the man-drawn sleds and 150 pounds per dog, with 75 pounds on the sled drawn by the pilot party, the total amount of food and supplies which can be hauled by the party would be almost two thousand pounds.

As the pilot party move more slowly than the party following their trail, it is possible for the dog teams to make back trips now and again and bring up the reserve supplies, which have been cached behind. As soon as the work is reached, the party breaks up into its component parts, the line-crew go off on line and keep the work moving without interruption, while the dog-man and his helper, who are now known as portageurs, bring up reserve supplies, make caches where needed, explore the country round in the direction which the line is taking and locate suitable camping grounds in advance. Camp is usually moved three times in two weeks, sometimes oftener, depending upon the nature of the work and the amount of cutting encountered. As none of the crews come in to dinner, taking food for the day with them when they leave in the morning, the cook has the day to himself, during which times he must do all the necessary cooking and baking and gathering of wood to provide good warm meals for both men and dogs on their return at night. The dogs are only fed once a day and that in the evening.

These notes refer to a profession closely allied to that of the engineer, a profession which has not dropped behind in the years during which it separated itself from the engineering profession but on the contrary has maintained the traditions which it inherited then and has added to them, until to-day it has become a complete and entire specialty of its own, carrying over the mathematical education and precision of the engineer to a close kinship with the legal profession.

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Some Considerations Governing the Undertaking of Hydro-Electric Power Developments

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Paper presented before the Quebec Branch of The Engineering Institute of Canada, January 14th, 1935.

SUMMARY.—The author notes the trend towards the combination of power development with flood control; deals with the respective advantages of steam and hydro-electric development; discusses the effect of various types of load; new uses for electric energy; and the factors affecting the location of power sites and the control of their water supply.

Various estimates have been made of the potential water power available in the world. It is obvious that such estimates must be at the best only guesses, as there are many rivers of which little is known as regards flow, profile, etc. Again the methods of calculation vary, as to whether minimum or six months or average flow is considered, whether total head or only suitable heads are considered, plant efficiency and other features.

A table published in 1933, gives the installed capacity of hydro-electric plants in various countries, and is of interest though it covers only a fraction of the potential power.

Water Power Development in Countries Having an Installed Capacity in Excess of 100,000 Kilowatts

Country	Rating, kw.	Per cent of total
1. United States	11,800,000	30.06
2. Canada	5,256,000	13.39
3. Italy	4,348,000	11.08
4. Japan	3,151,000	8.03
5. France	2,781,000	7.08
6. Germany	2,300,000	5.86
7. Switzerland	1,900,000	4.84
8. Norway	1,850,000	4.71
9. Sweden	1,400,000	3.57
10. Spain	875,000	2.23
11. Soviet Russia	758,000	1.93
12. Austria	725,000	1.85
13. Brazil	525,000	1.34
14. Finland	300,000	0.76
15. India	300,000	0.76
16. Mexico	235,000	0.60
17. Great Britain	228,000	0.58
18. New Zealand	225,000	0.57
19. Jugoslavia	190,000	0.48
20. Czechoslovakia	110,000	0.28
Total	39,257,000	100.00

In 1931 in the United States the total capacity of generators in all power plants both hydraulic and steam, generating electricity for public use was slightly over

36,000,000 kw. Compared with the above table it appears that the hydro-electric power plant installation in the United States was only about one-third of the total installation.

In Canada the greater amount of power is developed by hydraulic means. It is estimated that the minimum water-power possibilities of the Dominion are something over twenty million horse power under ordinary minimum flow and nearly thirty-four million horse power for six months of the year. The installed horse power at the end of 1933 was 7,332,000 h.p. and it has been estimated that the saving in coal, based on the kilowatt-hour output of the plants was nearly 15 million tons.

In a country where the few available coal deposits are far from the centres of industry this is a very important factor.

Trends in Hydro-Electric Power Development

The trend in hydro-electric power development has been interesting. The first sites to be developed were those prominent falls near centres of population; often they were falls which yielded little power, but enough for those days. Then, as the art of transmitting power advanced, more remote sites were developed, gradually increasing in size, but still the really large sites were not tackled. For a while there was talk of developing all available small sites—five hundred or a thousand kilowatts here and there all over the country. With the introduction of automatic and remote control equipment these small developments became popular due to their low operating cost. Then came the development of large low head sites. All the time increasing attention was being given to storage and river flow control. Recently power developments have been combined with navigation projects, as in the St. Lawrence river, and with irrigation and flood control, as the Hoover Dam development on the Colorado river.

In the United States in particular the idea of the combination of power development with flood control and irrigation or with navigation, has taken hold. Such sites are invariably costly to develop from a purely power standpoint, and would not be attempted were not state aid forthcoming. In some cases the state pays a certain amount to cover works done for the public good. In other cases the state has shouldered the whole burden with the intention of profiting thereby. An ambitious plan is now under way in the Tennessee Valley, where the United States government is developing a large water power and establishing flood control, and is endeavouring to improve the lot of the population. This is not the place to discuss the wisdom or otherwise of such a policy. It is certainly true that the United States government has provided the means and given the necessary impetus to these colossal projects which would not have been undertaken by any private corporation.

For any private corporation the undertaking of a hydro-electric power development is a business proposition which must pay its own way. However, when government aid is forthcoming to pay for those features of the undertaking which are for the public good, the development of power sites in conjunction with irrigation, flood control and navigation projects enables power to be obtained at reasonable cost from sites that would otherwise be uneconomical to develop. Some of the figures published with regard to the economics of such developments are not convincing. It is reasonable to assume that, if a site be uneconomical to develop for power purposes alone, but be developed in connection with flood control and irrigation or navigation, the sale of power alone will not pay for the whole project. If, however, the cost be divided in proportion to the value of each feature, the whole matter may be considered intelligently.

Steam Versus Hydraulic Generation

The popular belief that electricity generated by means of water power is always cheaper than that generated in steam plants, is a fallacy. The reason is, of course, the tremendous capital cost of hydraulic works, the cost of storage water as an operating charge, and the long distances over which hydro-electric power usually has to be transmitted, involving high investment in transmission lines, and continuous loss of power. Except in special cases careful analysis must be made to find which is the more economical method of generation.

There are certain conditions under which the development of water power sites is obvious, as there are others under which there is no choice as there are no hydro-electric sites available. There are many cases in which only estimates of the construction and operating costs of the two schemes will reveal which is the cheaper. Given equal cost there are other factors to be taken into account, such as the possibility of increasing capacity, obsolescence, etc.

The various important factors governing the choice of plants are tabulated below. Each type has inherent advantages and disadvantages, and all must be given consideration.

Steam Plants

Advantages	*Disadvantages*
Usually lower cost of installation.	Rapid obsolescence due to improvements in science.
Ease of expansion.	Necessity of transporting large quantities of fuel.
Nearness to load centre.	Less reliability.
	Difficulty in obtaining sufficient condensing water.

Hydro-Electric Plants

Advantages	*Disadvantages*
No fuel charges.	High cost of hydraulic works.
Less rapid obsolescence.	Variable stream flow, usually at minimum when load is greatest.
Perpetual life of hydraulic works.	High cost of storage water.
Greater reliability.	Usual remote locations meaning costly transmission lines and power losses.
	If full capacity of site generated no possibility of increasing capacity.

Many power systems are composed of a number of interconnected power plants, some steam and some hydraulic. There are certain instances of steam and hydro plants being built alongside of one another. One such plant, Holtwood, is worthy of notice.

The Susquehanna river has a great range in flow, and in order to obtain the maximum advantage from the water available at the plants at Holtwood and Safe Harbor a steam station was built alongside the Holtwood station. Coal for the steam plant is dredged from the forebay of the hydro plant. The Susquehanna river flows through the Pennsylvania anthracite deposits and brings down particles of coal which it deposits in the lower reaches of the river. It is estimated that there are over ten million tons of coal deposited in the bed of the river over a distance of eight miles. The steam plant is designed to burn this fuel. In this particular case it was convenient to have the plants together. Nearness to a supply of coal is not always a governing factor in the location of a steam plant. Although it seems almost unbelievable, it has been repeatedly shown that it is cheaper to transport energy in the form of fuel than to transmit the electrical energy that would be generated from the fuel, particularly if a long haul is involved. For large steam stations the availability of an adequate supply of condensing water is frequently a governing factor.

A point that comes to the fore in considering the gigantic power projects being undertaken by various governments is that of obtaining the maximum advantage from the power available. None of the plants will operate at one hundred per cent firm power. That is, with a certain installed capacity only a certain percentage may be considered as being available at all times. Figures for some of these projects are given below.

Hoover Dam, Colorado river....	73	per cent firm power
St. Lawrence projects..........	50	" " " "
Kennett Dam, Sacramento river	15	" " " "

There are two ways of using the surplus power over these percentages—either by providing loads that may be carried only when the power is available, or by providing steam standby capacity to bring up the amount of firm power available.

Now the cost of power in a generating station can be divided into two parts—cost of readiness to give service, and actual cost of service. The former item consists of the capital invested and all fixed charges, and the latter the actual cost of operation, such as fuel, labour, etc. Considering a hydro-electric development with a steam standby to bring the firm power up to the full installed capacity of the hydro plant, the cost of any power over the firm power rating of the hydro plant would be as follows:

> Cost of power above firm power rating of plant equals cost of readiness to give hydro service plus hydro operating plus cost of readiness to give steam service plus steam operation.

Such an expression looks formidable enough but the relationship between the various amounts may be such that the total is less than for straight steam generation.

It must be borne in mind that the cost per horse power of hydro-electric developments is increasing and will continue to increase; whereas the cost of steam generation is decreasing and will probably continue to decrease for some time to come. This gives the steam station an increasing advantage over the hydro-electric station. Steam costs decrease due chiefly to increasing steam efficiencies and use of cheap fuel. An example of this is that in 1917 a plant which burnt 3.5 pounds of coal per kilowatt hour was considered efficient. The present average consumption of coal in the United States is 1.4 pound per kilowatt hour, with a number of plants burning less than a pound per kilowatt hour.

Hydro-electric costs are mounting due to remoteness of sites and corresponding high construction and transmission line costs, and large loss of power in transmission. This latter is being reduced, but slowly. Should developments be undertaken in populated country the cost of property and flooding rights is enormous.

Available and Possible Load

In any undertaking for the supply of electric power there are many factors to be considered. The two fundamentals are of course first, a demand for power, and second, an available source of supply. As some considerable time elapses between the first studies and the completion of the work it is first of all necessary to make a study of the available load and how rapidly it will increase, so as to know what the demand will be when the undertaking is completed, and also to see how long the capacity decided upon will last. It is obviously necessary to anticipate the load for several years.

Having determined what the load will be at various times in the future it is necessary to decide what capacity is to be installed. Just as it is wise to provide for a certain period in advance it is also foolish to build too far in advance. However, if a hydro-electric development is contemplated it may not be economical to build to a certain capacity determined by the load owing to the necessity of building works at one time sufficient for the full capacity of the site. In such cases the turbines and electrical equipment necessary to produce power over and above the initial installation warranted by the available load cost a relatively small part of the total job. Consequently if the load can be increased the unit cost of energy will go down. There are three types of load that can be built up. These are—

(*a*) Firm power, that is power sold at a certain rate which the customer may use whenever he wishes, and which is always available;

(*b*) Off-peak power, that is power sold at a lower rate but which may only be used at certain hours of the day, to fill in between the peak loads and keep up the load factor of the plant.

(*c*) Dump power, which is sold at very low rates, usually in large blocks, and which may be curtailed at any time that the power company wishes. This is surplus power sold to various industries for process work at a rate low enough to compete with their existing means of supply, and yet at a rate sufficient to cover the investment charges on the development. This power can be cut off due to shortage of water or due to equipment being out of service, or when the firm power load builds up sufficiently so that the power may be put to work more profitably. In addition to helping to carry the charges during the time that the firm power load is being built up this sort of load is of great help during bad times when the firm power load falls off appreciably.

New Uses for Electric Energy

Contrary to the general impression, electric power is a commodity for which a market must be found. Potential buyers must be convinced that it is of use to them, and they must be persuaded to buy it. Of course, a certain amount of energy is sold as a matter of course for lighting and sundry purposes, but in order to sell power at a low rate, and at the same time operate at a profit a company must have a fairly concentrated load, and, according to the size of the company, a heavy load. In order to obtain load the public must be educated to the use of electricity, and at the same time devices must be produced that will consume current and be attractive to the consumer. The author will not attempt to enumerate the many new applications, but one such type of equipment, the electric steam generator, which has undergone considerable development in Canada is worthy of mention.

One of the great industries in eastern Canada is the manufacture of newsprint paper. It is an industry peculiarly adapted to the country as two principal requirements are wood and power. The mills are frequently built on rivers, many of which supply sufficient hydro-electric power to operate the mills. Often the wood is cut in the basin of the same river and floated or "driven" down to the mill. The power is used principally in grinding the wood to a pulp, and to drive the machinery in the mill. The usual rule-of-thumb method of calculation allows 50 to 75 horse power per ton of paper per day; that is, a mill producing 200 tons of newsprint a day would use about ten to fifteen thousand horse power. In addition to power a great deal of steam is required for use in various processes and in drying the paper.

The difficulty of finding something to do with the idle capacity in newly-built hydro-electric plants, where there is a large investment not earning anything, has been largely overcome by the installation of electric steam generators which take surplus power at rates which will supply steam at slightly less than by coal, but which may be cut off at short notice. The application of these electric boilers has not been limited to paper mills, but they are installed in a variety of places where a considerable quantity of steam is required.

This type of load is satisfactory because in addition to paying the carrying charges on the investment in hydraulic plant it can be dropped when a more profitable market appears, and from an operating point of view it is good because it is a purely resistance load.

The extent to which this boiler load has been built up in ten years is shown in the following table of the output of Canadian electric stations:

Year	1924	1933
Total output kw.h	8,135,604,000	17,553,001,000
Output less exports and boiler consumption	6,572,798,000	12,955,237,000
Exports	1,302,317,000	989,364,000
Boiler consumption	260,489,000	3,608,400,000

The domestic firm power consumption has doubled, the exported power has diminished, and the boiler power consumption has increased from an almost negligible quantity to over twenty per cent of the total consumption. This result has been obtained by active development and salesmanship by the power companies concerned.

The question as to the practicability of domestic heating by means of electricity has been given attention. As far as the direct use of electricity by space heaters, or by conversion into steam or hot water is concerned it seems unlikely that much will be done in cold climates, except in a few places where power is exceptionally cheap. However in more temperate climates there may be distinct advantages. It is possible that the so-called "heat pump" or reversed refrigeration may be made at a sufficiently low price to make it adaptable to residential heating. In temperate climates where the winter temperatures are not extremely low and the summer temperature is high a combined heating and cooling plant would be of great use. At the present stage of development these heat pumps can supply heat at about one-half the cost of direct electrical heating, and at about twice the cost of heating by use of various fuels, but of course the cost of the equipment is high.

Location of Power Sites

In order to get the maximum benefit from the available head in any river it is often necessary to survey a long section of the stream under consideration, and possibly choose a number of sites with a view to successive development with ultimate use of the total available head. Just picking out a suitable fall and developing it has been done in many cases with the result that the maximum power has not been developed. However the location of a power development does not depend entirely upon the profile of the river and the topography of the surrounding country, but a number of other factors must be considered. An interesting example of what can be done by thorough investigation of a long stretch of river has been described in a paper by C. R. Lindsey, M.E.I.C.*

The St. Maurice river has a drainage basin of approximately 16,000 square miles in area, and over a distance of 188 miles has a fall of 1,138 feet. Of this total drop 636 feet is comprised in ten distinct falls, and the balance is accounted for by various rapids. In the lower reaches of the river four plants had been installed up to 1928, using 380 feet of head. The Shawinigan Water and Power Company controlled 285 feet of this head with an installed capacity of 674,000 h.p. In 1928 the company was granted rights on the upper reaches of the river over a distance of 89 miles, and comprising a total fall of 630 feet. Of this total fall only 150 feet was concentrated in two major falls. The problem was to use as much of this available head as possible in the most economical manner. The scheme finally adopted made use of a total of 623 feet head in six plants, with a total installed capacity of 1,208,000 h.p. With the completion of these plants the water will be used ten times in its course down the river, and a total of 1,003 feet of the theoretical available head of 1,138 feet will be utilized. Apart from using all the available head, the arrangement of having the tailwater of one plant discharge directly into the forebay of the plant below drowns out rapids where in cold weather frazil ice forms. This is an important operating advantage.

The preliminary work for this proposed hydro-electric development necessitated surveys for possible hydro-electric developments at nineteen locations, comprising thirty-nine possible heads, and data relative to such parts of railway location, timber limits, and depots, Indian reservations and fish and game clubs as would eventually come within the flooded areas. In the study of this information fifty-one various schemes were given consideration and comparative estimates made, and as a result, plans for six developments were submitted to the government and given approval.

*"Considerations Governing the Location of Hydro-Electric Power Developments on the Upper St. Lawrence River." The Engineering Journal, July 1933, p. 293.

Water Supply

In the preceding discussion it has been assumed that the river under development has a regular and sufficient flow of water. Such cases are extremely rare, however, and the rivers of eastern Canada, with the exception of the St. Lawrence, have extremely variable flow. Many of the rivers in the province of Quebec have a flood over a hundred times that of the minimum flow. Usually the minimum flow will only supply a small proportion of the normal output of the plant, consequently it is desirable to find some means of increasing the natural minimum flow.

The amount of power which may be generated at any given site depends directly upon the head, and the amount of water available. On most streams or sections of streams that are in populated country river flow and precipation records are available, but when more remote sites are contemplated often the information obtainable is slight.

In considering the flow of any stream there are two things to consider, first, the natural flow, and secondly the possibilities for regulation of flow. The first is obtained either from existing hydrographic records, extending preferably over a long period of years, or from observations taken during the preliminary investigation. Where accurate information over a long period is available for one part of a river, readings taken in another section over a short period can be fairly safely co-ordinated. The natural flow of a stream depends chiefly upon the area of the drainage basin, the precipitation, the geological structure of the ground, natural storage in the form of lakes, and the degree of afforestation. This last has a very pronounced effect, as a sparsely-wooded watershed with a large area of lakes has, other things being equal, a much more regular flow than one that has no lakes.

The St. Lawrence river is an extremely well-regulated stream, as the maximum flow is only about double the minimum. This is accounted for by the fact that the Great Lakes act as shock absorbers and store excessive floods and later give up this water to the lower river. The Great Lakes system forms the greatest natural reservoir in the world. To regulate smaller streams it is necessary to form artificial reservoirs which are allowed to fill during times of flood and from which the impounded water is released when necessary.

By artificial regulation much can sometimes be done to improve the flow of streams, in particular with regard to minimum flow conditions. There are many rivers which have their sources in systems of lakes some of which are suitable for damming for storage of flood water. However it takes a great deal of stored water to make much difference to the flow of a stream. A flow of 1,000 second feet for a period of four months, would require a reservoir twenty-five square miles in area and fifteen feet deep. The ideal place at which to store water is at the place at which it is to be used. If there be sufficient capacity the maximum advantage is then obtained, because advantage is taken of the whole drainage area tributary to the river at the site of the development. This is the condition at the Boulder Dam where two years flow of the river can be impounded, but this cannot always be achieved. Apart from topographical conditions at power sites frequently the cost of flooding rights would be so high as to be prohibitive. Usually the storage has to be done far up the rivers.

Much important work has been done in this way by the Quebec Streams Commission and the power companies. Considering the St. Maurice river watershed again, a reservoir of nearly four million acre feet capacity has been formed by the building of the Gouin Dam, and another large storage basin behind the dam at Toro Rapids. The result has been that plants that would otherwise have had a very limited output during low water are able to deliver all the power required. The actual minimum unregulated flow of the St. Maurice river is in the neighbourhood of 6,000 c.f.s. and the flow can now be regulated to a minimum of 18,000 c.f.s.

The results achieved in many cases are little short of marvellous. It is claimed that at the Gatineau river plants of Paugan Falls, Chelsea, and Farmers Rapids, for several years no water has gone down the river except that which has actually gone through the turbines. However storage water costs money. If the storage works are built by the Quebec Streams Commission the cost of the works is paid in the form of an annual rental, if they are built by the power companies it comes to much the same thing as there is the interest and depreciation to look after as well as the actual operating costs. The existence of large storage possibilities near the head waters of a river may however justify a large expense in making use of these possibilities because the maximum amount of use may be obtained from the water impounded, as it can be used over and over again on its way down the river.

Geological Considerations

In conjunction with other considerations governing the location of a dam comes the important matter of foundations. Without an investigation of the geological features of a river serious errors might enter into the calculations.

As stated by R. F. Legget, A.M.E.I.C., in a recent paper*:

"It is perhaps not generally appreciated that the erection of a dam to retain water causes more interference with natural conditions than does any other civil engineering operation."

"There are three geological problems to be investigated in connection with the design of all dams, namely, the ability of the foundation bed to support the superimposed load proposed, the resistance that the foundation bed will offer to the increased hydrostatic pressure, and the possible effects of the creation of underground hydraulic gradients at the ends of the dam. A fourth problem has to be faced in all cases where earth movement has occurred at any section of the area to be covered by the dam, in determining how far the effects of this extend in the adjacent rock, and in assisting in the selection of the necessary protective features in the design."

In the preliminary work on the Upper St. Maurice river a study was made of the geology of the country, and when suitable dam sites were found an electrical prospecting method was used to determine the depth of bed rock.

In the location of the present Boulder Dam the geology of the canyon had a decided bearing, and it was partly due to the nature of the rock that the dam was built in its present location.

Apart from the dam site and its surroundings, knowledge of the geological features of the area to be flooded is most important. Owing to the presence of pervious formations the leakage from a reservoir formed by damming a stream might be so great as to materially lessen its usefulness.

Construction Organization

Behind all large undertakings there must necessarily be an efficient construction force. Good organization and management of the construction force means speed, economy and dependability of construction, and is therefore an important factor in the success of any enterprise.

The construction organization on a large hydro-electric power development is much like an army in the field, about the only difference being that nowadays living conditions must be better. First of all the force must be housed and fed, after that work must be organized so that there is a minimum of wasted effort. Possibly the most important part of a construction force like an army, is its line of communications. There must be an unfailing supply of rations, and ammunition in the form of materials of construction.

This business of moving in materials is probably the greatest problem in many cases. Sometimes a spur railway line may be run in to the site, but frequently the expense is too great in comparison with the total cost of the job, due to the remoteness of the site, so other means must be resorted to.

In the more remote parts of the provinces of Ontario and Quebec often the simplest way is to bring the material in in winter over snow roads. As in some parts of the country there is a great deal of muskeg, material can often be brought in comparatively easily in winter when everything is frozen solid, whereas in summer it would be impossible without the construction of solid roads. The transformers for the Matachewan substation in Northern Ontario were brought in in winter. Their full weight was twenty-six tons each, but this was reduced to fifteen tons by replacing the oil with nitrogen. Even fifteen tons is a fair weight when it has to be hauled over twenty-six miles of snow roads. Most of the material for the transmission line from Lake St. John to Quebec was taken in in winter, as at the time of construction the present road through the Laurentide Park was nothing but a trail.

For larger jobs more permanent arrangements must be made. For the Rapide Blanc development a road ten miles long was built from the Transcontinental Railway. The road itself was unusual. It was built to a width of twenty-two feet, of which ten feet was concrete and twelve feet gravel. Loaded vehicles kept to the concrete strip. Everything for the construction of the plant with the exception of crushed stone and gravel had to be hauled over that road, the whole amounting to about one hundred thousand tons. During the winter the road was kept open to automobile traffic. The heaviest pieces brought in over this road were the transformers. The normal weight of the transformers was 188 tons each, but this was reduced for shipping purposes to 107 tons by replacing the oil with gas.

Conclusion

The author has endeavoured in this paper to give some idea of the problems to be encountered when any hydro-electric power development is under consideration. The science of hydro-electric power engineering has made great advances in recent years, but the difficulties to be surmounted become greater all the time. The engineering profession has also increased its knowledge and it is hard to conceive of any problem that will remain unsolved for long.

*"Geology and Civil Engineering." The Engineering Journal, October, 1934, p. 438.

THE
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Modern Welding Methods

The rapid development of electric arc and other fusion welding processes during the last few years has given rise to many interesting technical problems, while the employment of these methods is having a profound influence on many branches of engineering work. The application of the welding art, however, tended at first to run ahead of the advances in theory and research, so that in some cases processes have been used without proper knowledge of their limitations and the underlying principles involved in their employment. This condition, though it existed to a limited extent in the earlier stages, has been and is being corrected, and success is being reached by methods based on increased knowledge of the metallurgy of the materials employed and systematic investigation of their properties and micro-structure. At the same time it has been necessary to work out the radical changes in design which the employment of welding has required in many structures and machines, and which must be based on a working knowledge of the possibilities of the processes employed. The development has further involved the training of a new type of craftsman, the welder, whose skill, while certainly not less than that of the old-time blacksmith, is of quite a different kind. The welder now has to meet the exacting requirements and tests of modern construction. His work must be carried out under rigid supervision, and his manual skill must be of a high order if the results are to be reliable.

It is now realized that in a fusion weld conditions arise which do not occur in any other form of joint. For example, both in the design and assembly of welded work, consideration must be given to the avoidance of distortion, and the relief of any internal stresses that may remain when the welds are finished. Comparatively small variations in the operator's technique may result in quite serious differences in the quality of his joints. The control of the welding current in arc welding depends on his dexterity, as well as on the suitability of the electrical equipment. If good work is expected of an operator he must be properly protected against burns; his comfort must be considered, and he must have the best type of welding screen, since he has to see clearly what is happening in a welding zone whose area is perhaps not more than one-tenth of a square inch. Success in the application of modern arc welding methods involves many other factors, such as a knowledge of how the metallic arc behaves; the reactions occurring between the arc, the parent material, the electrode and its covering; the manner in which the electrode metal is deposited, and the effect of all these on the mechanical strength of the resulting weld. In this connection it has been necessary to call in the physicist and the metallurgist. Without the information obtained by their detailed studies of the metallic arc, and their investigations of the micro-structure of weld metal and the parent material, welders would still be working largely in the dark, and welding methods could never have reached their present stage of reliability. They are now being used successfully for bridges and structural frames and for pressure vessels carrying very high pressures and temperatures. Confidence in their use has been gained through exhaustive tests and by X-ray and electro-magnetic examination of the interior of finished welds.

Thus the sphere of usefulness of modern welding is continually being extended, and an appreciation of its capabilities has become essential for engineers of all branches of the profession. The paper on "Modern Arc Welding," which is printed elsewhere in this issue of The Journal, will therefore be welcomed, for it presents a general view of the present state of the art, and embodies much of the experience of an engineer who has himself been actively concerned in many of the developments of which he writes.

His observations cover the essential considerations which must govern the engineer in selecting the most suitable process and equipment for any given piece of work; the precautions which must be adopted to ensure rapidity and reliability in execution, and the special ways in which welded work must be designed and treated to avoid trouble from residual stress. Warnings are given as to certain pitfalls which await the unwary engineer who is not familiar with the limitations imposed by the nature of the welding process. Many of Mr. Boyd's remarks, while referring specifically to arc welding work, are applicable to welds executed by other methods, as for example, his recommendations regarding the measures to be taken for the relief of stress, the systematic training of welders as craftsmen, and the need for constant supervision and inspection.

The hesitation shown by many structural and mechanical engineers in adopting welded joints and connections is apparently not so much due to lack of faith in the welding process as now carried out, as to a desire to have available records of long experience as to the behaviour of welded structures and machine parts or pressure vessels in actual service. When this experience has been gained—and it is rapidly accumulating—we may look forward to a much wider and more rapid development of welding as a basic engineering method.

Mr. Boyd's article is based on the addresses which he has delivered before a number of the branches of The Institute, and in conjunction with other papers which have already been published in our columns or which will follow, cannot fail to be of interest to a wide circle of our members.

The Third World Power Conference 1936

Invitations on behalf of the President of the United States were issued on September 24th, 1935, by the State Department to the nations of the world to participate in and send delegates to the Third World Power Conference to be held in Washington from September 7th to 12th, 1936, and to the Second Congress of the International Commission on Large Dams to be held concurrently therewith.

The World Power Conference was organized in 1923 for the purpose of serving as a medium for the interchange of data and experience on power resources, their development and use, and for the discussion of the technical, economic and social problems associated therewith.

The proposed subject recommended for consideration at the Third World Power Conference is "The National Power Economy: Physical and Statistical Bases; Technical, Economic and Social Trends; Organization of Fuel Industries and of Gas and Electric Utilities; Public Regulation; National and Regional Planning; Conservation of Fuel and Water Resources; Rationalization of Distribution; National Power and Fuel Policies."

Plenary meetings of the World Power Conference are held every six years. The first was held in London in 1924 and the second in Berlin in 1930. It is the third of these meetings which is scheduled to be held in Washington in 1936.

Sectional meetings within limited geographic areas are held between the larger general meetings. One such sectional meeting was held in Basle in 1926, another in London in 1928, a third in Barcelona and a fourth in Tokyo in 1929. The most recent of the sectional meetings was that held in Stockholm in 1933 under the joint auspices of Sweden, Norway, Denmark and Finland.

In addition to the general and sectional meetings and the publication of their transactions, the World Power Conference, through national committees designated for that purpose and through special committees, engages in certain activities, including the adoption of a system of forms for reporting the statistics of power resources—annual production, consumption, import and export.

The Secretary of the Canadian National Committee of the World Power Conference is Mr. N. Marr, M.E.I.C., Dominion Water Power and Hydrometric Bureau, Department of the Interior, Ottawa.

Highways and Motor Vehicles in Canada

An interesting report, mainly statistical in character, entitled "The Highway and the Motor Vehicle in Canada 1934," has been received from the Transportation and Public Utilities Branch of the Dominion Bureau of Statistics. In that year there were 93,000 miles of surfaced roads in Canada, over half of which were in Ontario, the total mileage of rural roads being over 400,000. Some ninety per cent of the surfaced mileage was gravelled. The expenditure on construction during the year amounted to more than forty-six million dollars, and nearly twenty million dollars were expended in maintenance. Some 10,000 miles of highways were kept open during the winter at a cost of about half a million dollars. The various provincial highway debts totalled four hundred and sixty-two million dollars.

The registration of motor vehicles is given by years, and showed a continuous and rapid growth up to 1931, when the first decline was recorded, an upward turn occurring in 1934. The total registration, now over a million, gives an average number of persons per vehicle of 9.6 as compared with 4.9 persons per vehicle in the United States. Particulars are given of the registrations by provinces and municipalities, there being some 542,000 vehicles in Ontario and 165,000 in Quebec. Montreal, although larger in population, has only 60,000 passenger cars as compared with 100,000 in Toronto.

As regards gasoline consumption, the gross sales of gasoline were over 530 million Imperial gallons, of which 479 millions were taxable, at a rate varying from 8 cents per Imperial gallon in the Maritime Provinces to 6 cents in Quebec and Ontario.

It is difficult to obtain comprehensive statistics as to motor vehicle accidents, but an attempt has been made to get comparative figures by tabulating the average number of deaths per 10,000 registered motor vehicles for the various years from 1926 onwards, this ratio showing a surprising range, from 3.28 in Saskatchewan to over 17 in the case of New Brunswick. The report notes, however, that these figures are of somewhat doubtful value, as they give no weight to differences in use of vehicles, climatic conditions, density of population, roads, character of cars, and other factors which affect the accident ratio.

Some interesting data follow as regards the entry of tourist automobiles, and the motor vehicle regulations of the various provinces are given, together with a summary of the various requirements as regards the licensing of public vehicles. The report will be found of value to everyone interested in motor traffic in Canada.

List of Nominees for Officers

The report of the Nominating Committee was presented to and accepted by Council at the meeting held on October 18th, 1935. The following is the list of nominees for officers as prepared by the Nominating Committee and published for the information of all corporate members as provided by Sections 68 and 74 of the By-laws.

List of Nominees for Officers for 1936 as Proposed by the Nominating Committee

President:	E. A. Cleveland, M.E.I.C.	Vancouver.
Vice-Presidents:		
Zone "B"	H. F. Bennett, M.E.I.C.	Sault Ste Marie.
	R. L. Dobbin, M.E.I.C.	Peterborough.
	F. W. Paulin, M.E.I.C.	Hamilton.
	C. M. Pitts, A.M.E.I.C.	Ottawa.
Zone "C"	A. B. Normandin, M.E.I.C.	Quebec.
Zone "D"	H. W. McKiel, M.E.I.C.	Sackville, N.B.
Councillors:		
‡*Cape Breton Branch*	Y. C. Barrington, A.M.E.I.C.	Sydney Mines, N.S.
‡*Moncton Branch*	T. H. Dickson, A.M.E.I.C.	Moncton.
‡*Quebec Branch*	H. Cimon, M.E.I.C.	Quebec.
††*Montreal Branch*	F. S. B. Heward, A.M.E.I.C.	Montreal.
	F. Newell, M.E.I.C.	Montreal.
‡*Ottawa Branch*	R. W. Boyle, M.E.I.C.	Ottawa.
	A. K. Hay, A.M.E.I.C.	Ottawa.
‡*Peterborough Branch*	A. B. Gates, A.M.E.I.C.	Peterborough.
	B. Ottewell, A.M.E.I.C.	Peterborough.
‡*Hamilton Branch*	E. P. Muntz, M.E.I.C.	Hamilton.
‡*Niagara Peninsula Branch*	W. R. Manock, A.M.E.I.C.	Fort Erie North.
	E. P. Murphy, A.M.E.I.C.	Port Colborne.
‡*Sault Ste Marie Branch*	F. Smallwood, M.E.I.C.	Sault Ste Marie.
‡*Winnipeg Branch*	T. C. Main, A.M.E.I.C.	Winnipeg.
‡*Lethbridge Branch*	G. S. Brown, A.M.E.I.C.	Lethbridge.
‡*Calgary Branch*	T. Lees, M.E.I.C.	Calgary.
	H. J. McLean, A.M.E.I.C.	Calgary.
‡*Victoria Branch*	H. L. Swan, M.E.I.C.	Victoria.

*One Vice-President to be elected for two years.
‡One Councillor to be elected for two years.
††Two Councillors to be elected for three years each.

Additional Nominations

Section 68 provides also that "Additional nominations for the list of nominees for officers signed by ten or more corporate members and accompanied by written acceptances of those nominated, if received by the Secretary on or before the first day of December, shall be accepted by the Council and shall be placed on the officers' ballot."

OBITUARIES

J. E. Noulan Cauchon, A.M.E.I.C.

Members of The Institute will learn with regret of the death at Ottawa, on October 28th, 1935, of J. E. Noulan Cauchon, A.M.E.I.C.

Born at Quebec, Que., on March 4th, 1872, Mr. Cauchon was educated at St. Boniface College, Manitoba, Point Levis College, Quebec, and privately.

Mr. Cauchon commenced his career with the Quebec and Lake St. John Railway at an early age, but remained

J. E. Noulan Cauchon, A.M.E.I.C.

only a few months before joining the staff of the Canadian Pacific Railway Company in Montreal. He stayed in the service of the Railway for more than twenty years, rising to the position of assistant to the chief construction engineer during the road's great expansion period. He ended this service in 1907 and spent the next two years as assistant engineer to the Board of Railway Commissioners. Mr. Cauchon then became actively interested in town planning, and subsequently devoted more than twenty-five years to that subject, becoming an internationally known authority.

As chairman of Ottawa's Town Planning Commission, Mr. Cauchon sought to make Ottawa a scientifically landscaped city of beauty and efficiency. He was an advocate of the hexagonal system of town planning and from the first realized that his science was not concerned merely with beautifying towns but also had sociological implications. In 1916 Mr. Cauchon went to Hamilton and evolved a scheme for a joint railway entrance and union station for the Grand Trunk and Canadian Pacific Railways. In 1917 he proposed an irrigation and cultivation scheme for Ontario from the Grand River to the Niagara, and offered it as the basis for soldier settlement schemes, self-contained garden cities and industrial decentralization; in the same year he undertook the valuation of the Canadian Northern Railway terminals across Canada.

In 1924 and 1925 Mr. Cauchon drew up zoning laws for Ottawa designed to be models for the Dominion. The next year he was appointed technical adviser to the Montreal Town Planning Commission, working with Professor P. E. Nobbs, of McGill University, and drafting a town-planning and zoning act for Quebec. During most of 1929 Mr. Cauchon was in Europe lecturing, returning there in 1931 as a delegate to the International Town Planning and Housing Congress in Berlin. In 1934 Mr. Cauchon served as an honorary technical adviser and expert witness before the Parliamentary Housing Committee.

Mr. Cauchon was a past-president of the Town Planning Institute of Canada and an honorary member of the Royal Architectural Institute of Canada. He was Canadian corresponding member on the general committee of the Town and Country Planning School of Welwyn, England.

He took an active interest in Institute affairs, and was chairman of the Ottawa Branch in 1927 and represented that Branch on Council in 1930 and 1931.

Mr. Cauchon joined The Institute (then the Canadian Society of Civil Engineers) as an Associate on April 14th, 1904, and became an Associate Member on April 17th, 1909.

George H. Davis, M.E.I.C.

It is with deep regret that the death of George H. Davis, M.E.I.C., at Toronto, Ontario, on September 6th, 1935, is placed on record.

Born at Toronto on February 28th, 1881, Mr. Davis' entire professional career was with the Canadian Pacific Railway Company. Joining the service in 1905, he was engaged on the preliminary and final location of the Georgian Bay and Seaboard Railway; and in 1906-1907 on the preliminary location of the Campbellville, Lake Ontario and Western Railway. From 1907 until 1909 Mr. Davis was occupied on the construction of the Georgian Bay and Seaboard Railway, including Port McNicoll terminal, docks and elevators, and later in 1909 became draughtsman for the division engineer of construction, at Toronto; in 1909-1910 he filled the same position with the district engineer of the Ontario district. In 1910-1912 Mr. Davis was in charge of construction of double track work, and later was assistant engineer of terminals at Toronto. In 1912 he was appointed division engineer, Toronto Terminals, Ontario District, and from 1913 until 1915 was assistant district engineer of Ontario District, being made division engineer, Toronto Terminals, on February 1st, 1915. In May, 1915, Mr. Davis became assistant district engineer, Quebec District, at Montreal which position he held until 1918 when he was appointed division engineer, Toronto Terminals. From August 1918 until 1920 Mr. Davis was assistant district engineer, Quebec District, at Montreal, and in 1924 he became assistant district engineer, Ontario District, at Toronto, which position he held until the time of his death.

Mr. Davis joined The Institute as a Member on March 25th, 1925.

PERSONALS

S. J. Hayes, Jr.E.I.C., has been appointed lecturer in engineering at the Memorial University College, St. John's, Newfoundland. Mr. Hayes was formerly located in Toronto, Ont.

J. W. Gathercole, Jr.E.I.C., has joined the staff of Price Brothers Limited at Kenogami, Que., as steam plant engineer. Mr. Gathercole was formerly with the Canada and Dominion Sugar Company Ltd., Montreal.

J. L. Pidoux, Jr.E.I.C., assistant highways engineer, Department of Public Works, Alta., Calgary, who graduated from the University of Alberta with the degree of B.Sc., in 1934, has been awarded the John Bonsall Porter Scholarship for 1935-1936. The scholarship is open to graduate students proceeding to the degree of Master of Engineering in civil engineering at McGill University.

D. L. McLean, A.M.E.I.C., was recently appointed assistant chief engineer of the Greater Winnipeg Sanitary District, in direct charge of the construction of $4,000,000 worth of intercepting sewers and a disposal plant. Mr. McLean graduated from McGill University in 1909 with the degree of B.Sc., and following graduation became assistant to J. B. McRae, M.E.I.C. consulting engineer, Ottawa, and later was assistant chief engineer for the International Commission. He was then appointed chief engineer in connection with the water power surveys of the Winnipeg rivers, being carried on by the Dominion Water Power Branch, Department of the Interior. Later Mr. McLean became chief engineer of the Manitoba Drainage Commission, and in 1922 he was appointed deputy minister of public works for the province of Manitoba. In 1929 he became Manitoba Power Commissioner. In 1932 Mr. McLean was appointed chairman of a Hydro-Electric Power Commission appointed by the Manitoba government, in addition to being general manager of the city of Winnipeg Hydro-Electric System. Mr. McLean has taken a prominent and active part in the affairs of the Winnipeg Branch of The Institute and represented it on the Council of The Institute in 1926 and 1927.

E. G. Cullwick, Jr.E.I.C., has returned to the University of British Columbia, Vancouver, as associate professor of electrical engineering. Mr. Cullwick graduated from Cambridge University in 1925 with the degree of B.A. in engineering, and following graduation was for a time connected with the Canadian General Electric Company Ltd. at Peterborough, Ont. He was then appointed assistant professor in electrical engineering at the University of British Columbia, and early this year resigned to join the professional staff of the Military College of Science, Woolwich, England, as lecturer in electrical engineering.

C. D. Howe, M.E.I.C., managing partner of C. D. Howe and Company, Port Arthur, Ont., who was elected to Parliament as Liberal member for Port Arthur in the elections held recently, has been appointed Minister of Railways and Canals and Minister of Marine.

Mr. Howe graduated from the Massachusetts Institute of Technology in 1907 with the degree of B.Sc., and was subsequently assistant in the structural engineering department of the same university. From 1908 until 1913 he was professor of civil engineering at Dalhousie University, Halifax, and also acted as a consulting engineer on important factory and warehouse structures. From 1913 until 1916 Mr. Howe was chief engineer of the Board of Grain Commissioners of Canada and was in charge of the design and construction of terminal grain elevators at Saskatoon,

The Hon. C. D. Howe, M.P., M.E.I.C.

Moose Jaw, Calgary and Vancouver. In 1916 Mr. Howe established the firm of C. D. Howe and Company, consulting engineers, at Port Arthur, Ont., and since that time has designed and superintended the construction of many large grain elevators. He also surveyed the grain handling situation in the Argentine for the government of that country. In the past few years Mr. Howe has travelled extensively, studying world trade, particularly factors affecting the grain business.

Burton M. Hill, M.E.I.C., was elected Member of Parliament for Charlotte county, New Brunswick, in the general election recently held.

Mr. Hill graduated from the University of New Brunswick with the degree of B.Sc. in 1907, and was

Burton M. Hill, M.P., M.E.I.C.

subsequently engaged in civil engineering work; ten years in railroad work in various capacities as resident engineer, divisional engineer and chief engineer on location and construction work. In 1917 he took over the organization of the permanent highway department for the province of New Brunswick, and occupied the position of chief highways engineer until 1925 when he was taken into the provincial cabinet of New Brunswick as minister of public works. In 1929 he was made one of the commissioners of the Saint John Harbour. Since 1931 Mr. Hill has been managing director of Consolidated Diversified Standard Securities, Montreal.

In connection with Mr. Hill's election it is interesting to note that his grandfather, the Hon. George S. Hill, was a member of the legislature of New Brunswick from 1830 to 1848, and a member of the Legislative Council from 1848 to 1858. His uncle, the Hon. George F. Hill, represented Charlotte county in the legislature of New Brunswick from 1865 to 1908, twenty-five years of which he was a member of the Legislative Council, and was president of this Council at the time of its dissolution.

Elections and Transfers

At the meeting of Council held on October 18th, 1935, the following elections and transfers were effected:

Associate Member

HUDSON, Arthur Magennis, equipment engr., Dept. of Northern Development, Toronto, Ont.

Junior

SANDWELL, Percy Ritchie, B.A.Sc., (Univ. of B.C.), dftsman., Paper Machy. Dept., Dominion Engineering Works Ltd., Montreal, Que.

Transferred from the class of Junior to that of Associate Member

BEAM, Donald Carleton, B.A.Sc., (Univ. of Toronto), struct'l. engrg., bldg. dept., City of Toronto, Ontario.

JACKSON, Charles H., B.A.Sc., (Univ. of Toronto), production mgr., ammunition divn., Canadian Industries Ltd., Brownsburg, Que.

MOORE, Alexander Glydon, B.Sc., (N.S. Tech. Coll.), asst. supervisor, underground elect'l. distribution, Montreal Light, Heat & Power Cons., Montreal, Que.

WILLIS, Reuben Wesley, B.Sc., (Queen's Univ.), designing engr. of bridges, dept. of works, City of Toronto, Ontario.

WRANGELL, Kjell Frederick, (Horten Tekniske Skole), mech'l. engr., The E. B. Eddy Co. Ltd., Hull, Que.

Transferred from the class of Student to that of Associate Member

LEGG, John Herbert, B.Sc., (McGill Univ.), mill supt., Aldermac Mines Ltd., Niagara Falls, N.Y.
MOFFAT, Thomas Stuart, B.Sc., (McGill Univ.), supt., Provincial Wood Products Co., Saint John, N.B.
NICOLAISEN, Juncker Zelo, B.Sc., (Univ. of Durham), Villa Egemaes, Espergaerde, Denmark.
PEEBLES, Archibald, B.A.Sc., (Univ. of B.C.), instructor, dept. of civil engrg., University of British Columbia, Vancouver, B.C.
RHODES, Donald, B.Sc., (McGill Univ.), district engr., Bell Telephone Company of Canada, Sherbrooke, Que.
ROSS, William Bruce, B.Sc., M.Sc., Ph.D., (McGill Univ.), lecturer in mathematics, McGill University, Montreal, Que.
SHEARWOOD, Alexander Perry, B.Eng., (McGill Univ.), asst. engr., National Steel Car Corpn., Montreal, Que.

Transferred from the class of Student to that of Junior

ELLIOTT, Lisgar Webster, B.Sc., (Univ. of Alta.), engr., receiver development dept., Canadian Marconi Co., Montreal, Que.
McKAY, Robert Donald, B.Sc., (N.S. Tech. Coll.), Graduate School of Engineering, Harvard University, Cambridge, Mass.
SKELTON, Cecil Hastings, B.Sc., (McGill Univ.), research engr., Consolidated Paper Corpn., Three Rivers, Que.
THOMPSON, Frank Lawrence, B.Sc., (N.S. Tech. Coll.), tech. service engr., Imperial Oil Ltd., Dartmouth, N.S.
TREMAIN, Kenneth Hadley, (Grad. R.M.C.), B.Sc. (McGill Univ.), asst. sales mgr., The Elias Rogers Co. Ltd., Toronto, Ont.

Students admitted

BLOOM, David, B.Eng., (McGill Univ.), 660 Querbes Ave., Outremont, Que.
FRIGON, Rosario, B.A., (Ecole Polytechnique, Montreal), 169 Sherbrooke, St. East, Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Naval Architects: Transactions 1935.
Society for the Promotion of Engineering Education: Proceedings of 42nd Annual Meeting.
Highway Research Board, National Research Council: Proceedings of 14th Annual Meeting, 1934.

Reports, etc.

American Society for Testing Materials: Year Book 1935. Supplement for Book of Standards, 1935.
Canada, Dept. of Mines, Mines Branch: Wood Fuel Burning Tests, Malloch and Baltzer.
Road Gravels in Quebec, R. H. Picher.
Royal Technical College Glasgow: Calendar, 1935-36.
American Institute of Steel Construction: Annual Report 1935.
Canada, Bureau of Statistics: The Highway and Motor Vehicle in Canada, 1934.
Research Council of Alberta: Annual Reports, 1932, 33 and 34.

Technical Books, etc. Received

Industrial Electronics, by F. H. Gulliksen and E. H. Vedder. (*John Wiley and Sons, New York.*)
Elements of Machine Design, by D. S. Kimball and J. H. Barr. (*John Wiley and Sons, New York.*)
Materials of Testing, J. H. Cowdrey and R. G. Adams. (*John Wiley and Sons.*)

BULLETINS

Gear Motors—A 16-page bulletin has been received from the Dominion Engineering Company Ltd., Lachine, Que., describing and illustrating the line of gear motors manufactured by that company. These are available in ratings from ½ h.p. to 40 h.p. at ratios giving output speeds from 5,000 r.p.m. down to 10 r.p.m. These are drive units in which enclosed gearing and an electric motor are so arranged that for purposes of installation the assembly may be considered as a single piece of equipment. Tables indicating correct sizes of units for given horse powers and ratios are included.

Flashers and Controls—An 8-page booklet issued by Betts and Betts Corp., New York, N.Y., gives particulars of their high speed type flashers and controls designed to operate neon tube and bulb signs.

Tube Fabricating Equipment—The Parker Appliance Company, Cleveland, Ohio, have issued a 24-page bulletin describing the equipment used in the fabrication of tubes.

Bearings—A 110-page completely indexed catalogue has been received from Ransome and Marles Bearings Canada Limited, Montreal, which includes types and sizes of bearings not listed in the older editions. Engineering data is furnished on ball journals, double purpose bearings, motor cycle bearings, roller journals, thrust bearings, mounting, housings, lubrication and tolerances for shafts and housings. Prices are given. Copies furnished on request.

BOOK REVIEWS

Elementary Structural Problems in Steel and Timber

By Professor C. R. Young, M.E.I.C. John Wiley and Sons Inc., New York, 1935. 6 by 9¼ inches, 315 pages, diagrams. $4.00. Cloth.

Reviewed by P. L. Pratley, M.E.I.C.*

The present reviewer finds it practically impossible to describe with the aid of one adjective the impressions raised by a perusal of the compilation made by Professor Young under the above title. To the engineer continuously engaged in the solving of such problems, the book may almost be classed as fascinating, and it was with difficulty that the reviewer refrained from attacking all the exercise problems given at the end of each section.

To the young graduate engineer interested in his profession and starting out in a designing office the book should surely be useful, while to the student still in college it should serve as a most valuable link between theory and practice and also as a stimulant encouraging the reader to master the fundamental principles by means of which the various problems are solved.

There is, perhaps, a certain latent danger in suggesting to such a student that all problems can be solved as simply and as straightforwardly as those in the book, and by the application of standard formulæ. It is manifestly impossible to combine with such a selection of practical problems the theory upon which the solution is founded, and references are accordingly given in the book, at certain places, to standard texts where the interested student may find the demonstration or derivation upon which the quoted formulæ are built. Nevertheless, it is, in the reviewer's opinion, somewhat risky to include without explanation such formulæ as number 23, article 72, page 75, as the necessity and effect of such a correction factor are not readily appreciated. The present reviewer, in his own career, has never before seen such a factor and is rather inclined to regret its introduction.

Generally speaking, the problems are very plainly stated and the solutions very clearly demonstrated, and insofar as the word "elementary" enters into the title of the book, the number and nature of the problems would appear to be very wisely selected. Naturally, there are features where a legitimate difference of opinion may arise as to the validity of assumptions and even as to the resulting detail, but these are very few considering the scope of the work. In problem 94, for example, the references to the initial stress in the tie-rod might well be disputed, and the same question arises in problem 186. In problem 122, the author works out the moment of inertia of a plate girder by two methods and finds a resulting divergence of 19.4 per cent. Although his closing paragraph refers in a casual manner to the shape of his plate girder, it would have appeared more logical to have made a similar comparison for the more usual type where the divergency is nothing like 19.4 per cent. This comparison might have been effected in the succeeding problem, 123, where in spite of the assertion made toward the end of problem 122, the so-called approximate method is used. On page 176, the detail of the roof truss at panel point U1 is decidedly at variance with good shop practice and even at U5 a top cover plate would normally be used instead of the eight rivets on the 4-inch leg.

The odd misprint will persist in appearing in such technical script, but very few came to the reviewer's notice while reading this work. That on page 71 in the third line where the "multiplication" sign is used for the "equals" sign might be a little troublesome to the less experienced reader. On page 91, in figure 52, it would be to some advantage if the dimensions from the neutral axis to the back of the angles and to the toes, namely: 1.14 inch and 2.36 inch, were incorporated in the figure.

As is undoubtedly the author's intention, the book will find its greatest field in the hand of the young engineer just beginning to apply his theory to practice; but the reviewer feels that a good many ex-graduates might do worse than tackle some of the exercise problems as a means of keeping themselves in touch with the principles which have a universal application but which are sometimes violated by those who should know better. In this manner, Professor Young's book might perform a very useful service in the maintenance field by preserving the engineer's acquaintance with the fundamental theories upon which his formulæ are based. In the reviewer's opinion the acquaintance with the principles is of much more importance than the memorizing of formulæ or extracting them from a textbook, and one of the best methods to maintain an appreciation of the principles is to apply them to such problems as Professor Young outlines.

*Monsarrat and Pratley, Consulting Engineers, Montreal.

Practical Designing in Reinforced Concrete Part III

By M. T. Cantell. E. and F. N. Spon, Limited, London. 1935. 5½ by 8¾ inches, 221 pages, photos, diagrams, tables. 12/6. Cloth.

Reviewed by J. F. Brett, A.M.E.I.C.*

The book begins with an elementary chapter on tall chimneys, seven pages being devoted to this subject. Then follows a six-page chapter on dams, where the author gives some historical data and briefly discusses the principal features of gravity and Ambursen dams without attempting to go into design.

Beam bridges is the title of the next chapter, and here the author elaborates a little more, the data given being still elementary. There is a worked-out example of a 30-foot bridge. On page 20 it is stated that bridge sidewalks are generally designed for a live load of 150 pounds per square foot, an erroneous assumption.

Over one hundred pages are devoted to the treatment of arches and arch bridges. The graphic and elastic methods are both given and elaborated by worked-out examples: the data given here are in general sufficiently thorough to be of value in designing. The reviewer, however, wishes to draw attention to page 28, where it is stated that "the centre line of arch is called the neutral axis or neutral surface curve" and would emphasize that the arch axis is not the neutral axis in a reinforced concrete arch.

In the chapter dealing with temperature shortening and moisture stresses in arches, page 43, the now well-known phenomena of time flow should have been described in connection with shrinkage and other volume charges, since the influence of the former is perhaps the most important.

There is a chapter on hinged arches, where some forms of hinges and temporary hinges are mentioned, but no design data are given.

The author then touches on skew arched bridges, devoting less than five printed lines to the subject. Besides the mere statement that they are designed in the same way and by the same formulæ as square arched spans, the reviewer feels that the reader's attention should have been drawn to the important stresses caused by the condition of skew, neglect of which has been the cause of many failures.

Arch abutments, unsymmetrical arches, arched conduits and box culverts are then discussed, sufficient data being given in these chapters for designing the simpler cases.

Influence lines for fixed arches are next dealt with in a separate chapter. The method here used is based on the general method of analysis by the elastic theory as developed by Turneaure and Maurer which the author explains when dealing with concentrated loads. A short treatment of the arched conduit and the box culvert follows.

The author then passes on to what he calls "rigid structures" including under this item continuous beams and rigid frames. Some thirty-four pages are devoted to the subject, several worked-out examples being given. The methods of analysis employed are the elastic theory and the moment distribution method of Professor Hardy Cross. The data here presented may serve as a good introduction to the study of monolithic structures.

There is a chapter on concrete dome design well worth reading, and another one, the last, on earthquake resisting structures, which includes valuable data from direct observation and a rational method of design. Basic formulæ pertaining to arches are given in the appendix, some eleven pages being devoted to these.

It is certainly no easy task to attempt to cover the structural features of so many different types of structures within the compass of a demy 8vo book of some two hundred pages. This explains the rather short treatment of some of them. Many of the chapters, however, contain a great deal of valuable practical information and in any case the volume will serve as a useful introduction to the subject.

The reproduction of a number of working drawings showing the general arrangement of reinforcing steel would add to the value of the book.

Division Engineer, Montreal Water Board, Montreal.

The Story of the Tunnelling Companies R.E.

by Captain W. G. Grieve

The investigation carried out during the past three years of the activities of the Tunnelling Companies during the War has now been completed.

This story will be published in the next few months and the Committee of the Tunnellers' Old Comrades Association wish to draw the attention of mining engineers to this unique publication, entirely connected with the work during the War of members of their own profession.

Copies may be reserved on the understanding that the cost will not exceed one guinea per copy, by writing to the Hon. Secretary, T.O.C. Association, c/o The Institution of Mining and Metallurgy, Salisbury House, Finsbury Circus, London, E.C.2.

Province of Quebec Association of Architects

A booklet containing its Charter, By-laws and Code of Ethics has been issued by the Province of Quebec Association of Architects. The publication is of interest to Institute members at this time, since the President of the Association, Mr. Gordon McL. Pitts, A.M.E.I.C., under whose auspices it was prepared, is also chairman of The Institute Committee on Consolidation.

It gives the text of the Architects' Act, incorporating the Association, with the most recent amendments, together with the By-laws of the Association, which regulate such matters as the requirements for membership; the professional examinations; the duties of officers, Council and committees; the relations of the Association with The Royal Architectural Institute of Canada and the fees payable to the Association. The regulations governing professional practice and discipline and proceedings at meetings are followed by the Association's Code of Ethics as adopted in 1935.

Requests for copies may be addressed to The Honorary Secretary of the Association, 627 Dorchester Street West, Montreal.

List of New and Revised British Standard Specifications

(Issued during July and August, 1935)

B.S.S. No.

617—1935. *Identification of Pipes, Conduits, Ducts and Cables in Buildings.*
Intended to be applicable to buildings other than those used for industrial processes but the provisions of the specification can be taken as a basis by factories or industries adopting schemes of identification. Represents general practice, and consists of a distinguishing colour and a specially shaped identification plate for each service.

618—1935. *Emulsions of Road Tar and of Road Tar-Asphaltic Bitumen Mixtures for Penetration (Grouting and Semi-Grouting) and Surface Dressing.*
Specification for a cold road dressing, incorporating tar. Appendices give methods of sampling and testing of the emulsion.

620—1935. *The Dimensions of Grinding Wheels and Method of Attachment.*
Dimensions of the most generally used shapes and sizes of grinding wheels, and of the flanges and washer plates to be used with the standard method of attachment. The tolerances and fits of the spindle in the wheels are specified, together with the quality of the material from which the spindle and flanges are to be made.

621—1935. *Wire Ropes of Special Construction for Engineering Purposes, inclusive of Cranes, Lifts and Excavators.*
Providing for Seale construction, oval and flattened strand and multiple strand wire ropes from 1½″ to 6″ circumference for special engineering purposes including cranes, lifts and excavators.

622—1935. *Cyanide (Classes A and B) suitable for Electro-plating.*
The adoption of this specification when ordering cyanide for electro-plating will remove to a large extent the risk of damage to electro-plating baths, and the consequent loss to the plater.

623—1935. *Colours for Signal Glasses for Railway Purposes.*
(Issued 2-9-35) Covers the colorimetric and photometric properties of the glasses and methods of measurement of colour and transmittance.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

The Chemistry of Cement and Concrete

The Chemistry of Cement and Concrete, by F. M. Lea and C. H. Desch, published by Edward Arnold and Company, London, and costing $7.50 in Canada, gives a general survey of the Chemistry of cement and concrete, interpreting the title in a broad sense. The constitution of cements, the nature and properties of the compounds they contain, the properties of set cements and of the hydrated compounds present in them are fully described. The importance of cementing materials other than Portland Cement is now so great that considerable space is devoted to a description of Portland blast-furnace and other slag cements, aluminous cement and pozzolanas.

The testing of cement is only discussed in general outline, as this subject has been dealt with fully in various other works. For the same reason no mention is made of the methods of operating a cement plant, the general principles of concrete mixing, nor of the machinery employed.

The nature of various concrete aggregates, and any special properties inherent in them which favour or militate against their successful use, are critically discussed. The behaviour of concrete in use is dealt with at length. Such topics as its resistance to sea water and to soils containing soluble sulphate salts or acid water and its use for factory floors and in pipes for sewage effluents are all considered. An attempt has been made to outline the conditions which may be expected to affect concrete deleteriously. The survey made is based both on practical experience and on the results of the many large-scale trials and exposure tests which have been published. It represents the most ambitious survey of this type which has been attempted, and it is hoped that it may prove of real value to engineers.

Erratum—October Journal, page 459—in line 23 of the paper "Heavy Forgings and the Use of Alloys" by Messrs. M. F. McCarthy and E. Voorhees, for "1842" read "1742" and for "Dustman" read "Huntsman."

Returns on the "Questionnaire" of the Committee on Consolidation to October 24th, 1935

QUESTIONNAIRE OF THE COMMITTEE ON CONSOLIDATION

1. Are you in favour of the broad principle of Consolidation of the Engineering Profession in Canada?
2. In your opinion, should the corporate membership of the Provincial Professional Associations and of the National organization be identical?
3. Are you in favour of The Engineering Institute of Canada being accepted as the National body of the consolidated engineering profession in Canada?
4. Under Consolidation, would you be willing to pay a single annual membership fee which would include a uniform subscription from each member of the profession throughout Canada to the National organization?
5. In view of the fact that discipline and legal action are at present a function of the Provincial Associations, are you in favour of the administration of admission to membership and collection of fees also being made the responsibility of the Provincial organizations?

Province of Nova Scotia

*Cape Breton Branch (38)**

The Cape Breton Branch answered the "Questionnaire" as follows:
Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes.
Question No. 4—Yes.
Question No. 5—(held pending information as to any alternative suggestions which may be forthcoming).

Halifax Branch (106) and Association of Professional Engineers of the Province of Nova Scotia (204)

The Halifax Branch of The Institute and the Professional Association of Nova Scotia appointed a special Joint Committee whose members were:—Messrs. R. L. Dunsmore and C. S. Bennett, representing the Branch, and Messrs. C. M. Smyth, L. H. Wheaton and Professor F. R. Faulkner representing the Association. This Committee considered the "Questionnaire" and their findings, as the official expression of the Branch and of the Association, are as follows:
Question No. 1—Yes.
Question No. 2—No, not necessarily.
Question No. 3—No, not as at present constituted.
Question No. 4—Yes.
Question No. 5—Yes.

Questions Nos. 1, 4 and 5 are answered in the affirmative in view of the recommendations of the "Joint Committee of Eight" last January. "In answering Question No. 3 the fact that only about 50 per cent of the members of the Association of Professional Engineers in Nova Scotia are also Corporate Members of The Engineering Institute of Canada was taken into account."

Province of New Brunswick

Moncton Branch (27)

The "Questionnaire" was issued to the members of this Branch for an expression of their individual opinions and the results were as follows:
Question No. 1—Yes, 20; No, 0.
Question No. 2—Yes, 20; No, 0.
Question No. 3—Yes, 18; No, 2.
Question No. 4—Yes, 20; No, 0.
Question No. 5—Yes, 12; No, 7.

Three members also sent in suggestions, explanatory remarks or questions.

Saint John Branch (53)

The "Questionnaire" was issued to the members of this Branch for an expression of their individual opinions and the results were as follows:
Question No. 1—Yes, 28; No, 0.
Question No. 2—Yes, 27; No, 1.
Question No. 3—Yes, 27; No, 1.
Question No. 4—Yes, 26; No, 2.
Question No. 5—Yes, 23; No, 5.

Association of Professional Engineers of the Province of New Brunswick (141)

The Association has prepared and issued to its members a special bulletin and questionnaire on Consolidation, a report on the results of which appears herewith. At the same time, a Special Provincial Committee has been formed in New Brunswick composed of two representatives from the Moncton Branch of whom Mr. H. J. Crudge is one; two representatives from the Saint John Branch, Mr. Gilbert G. Murdoch and Mr. A. A. Turnbull; and four representatives from the Professional Association, Professor A. F. Baird, Mr. Geoffrey Stead, Mr. L. L. Theriault, and Mr. C. S. MacLean. The Commission of this Committee is: "To act with two members appointed by the Saint John Branch of The Engineering Institute of Canada and two from the Moncton Branch as a Committee to consider Consolidation in all its aspects; to take steps to prepare a scheme whereby it may be brought about; to co-operate with Mr. Kirby and the Committee of Eight (Dominion Council) and with the central committee of The Institute headed by Mr. Pitts, and with other bodies of The Institute or of the Provincial Associations working toward this end."

Special Questionnaire on Consolidation issued by the New Brunswick Association

(Note:—It is not suggested that the National Corporation shall exercise any of the powers now exercised by the Provincial Corporations such as "Admission to Membership" or "Disciplinary Action," etc.).

(1) *Do you favour a National Body?*
Yes, 51; No, 3.
(2) *Do you favour a form of amalgamation with The Engineering Institute of Canada under a revised constitution for the latter?*
Yes, 41; No, 10.
(3) *Do you favour an independent new Corporation composed of Registered Professional Engineers only?*
Yes, 10; No, 39.
(4) *Would you be willing to pay a higher annual fee than that at present set by the Provincial Association for the support of a National Corporation up to say:*
$5.00 per year
or 10.00 per year
or 15.00 per year.
Yes, $5, 3.
Yes, $10, 9.
Yes, $15, 21; No, 1.

Twenty of the above members submitted suggestions, explanatory remarks or questions.

Province of Quebec

Saguenay Branch (27)

The "Questionnaire" was issued to the members of this Branch for an expression of their individual opinions and the results were as follows:
Question No. 1—Yes, 20; No, 1.
Question No. 2—Yes, 15; No, 5.
Question No. 3—Yes, 20; No, 0.
Question No. 4—Yes, 18; No, 2.
Question No. 5—Yes, 14; No, 5.

Quebec Branch (91)

At a Special General Meeting this Branch considered and discussed the "Questionnaire" and reported as follows:
Question No. 1—Yes.
Question No. 2—Yes, *eventually;* but, at the beginning and for some time to come we feel that some members of the E.I.C. may not necessarily become members of the Provincial Association of their province.
Question No. 3—Yes.
Question No. 4—It would be desirable to pay a single fee which would include all privileges available to the profession. However, it is premature to agree that the single fee should include a *uniform subscription* from each member of the National organization without knowing whether the benefits to accrue to each member will be almost uniform or widely different as at present, due to the location of Headquarters and Branches.
Question No. 5—Yes.

Note:—We again wish to go on record as recommending that the present grade of E.I.C. Affiliate be abolished.

★*Saint Maurice Valley Branch (27)*

No communication has been received from this Branch.

Montreal Branch (735)

At the direction of a Special General Meeting the "Questionnaire" was circulated to all corporate members of the Branch for an expression of their individual opinions and the replies were as follows:
Question No. 1—Yes, 295; No, 13.
Question No. 2—Yes, 246; No, 10.
Question No. 3—Yes, 298; No. 10.
Question No. 4—Yes, 273; No, 21.
Question No. 5—Yes, 193; No, 52.

There are 48 of the above members who submitted suggestions, explanatory remarks or questions. Three members of this Branch answered all five questions in the negative.

Corporation of Professional Engineers of the Province of Quebec (990)

At its Annual Meeting of March 27th, 1935, the Corporation adopted the following report of a Special Committee on Affiliation. Resolved:

(1) That the Corporation of Professional Engineers of Quebec is ready and willing to co-operate immediately with the other Provincial Engi-

neering organizations in an attempt to develop with The Engineering Institute of Canada a suitable and adequate basis of co-ordination of the Engineering profession in the Dominion.
(2) That the lines along which such co-ordination should proceed be generally similar to those which have governed the organization of sister professions.
(3) That The Engineering Institute of Canada should rightfully be the national co-ordinating body, its corporate membership to consist solely of members of the Provincial Professional Associations
(4) That in order to overcome a serious obstacle existing at present, it be suggested that any corporate member of The Engineering Institute of Canada, at the time of such change, who is not qualified to belong to his local Professional body should remain a corporate member of the National body but shall not, by reason of such change, become a member of the Association or Corporation in the province in which he resides.
(5) That The Engineering Institute of Canada should, after the date of such change, admit no person to corporate membership who is not at the time of application a member of his own local Provincial body.
(6) That a copy of this resolution be immediately referred to the Corporation's representative on the Committee of Eight for transmission by him to the other members of this Committee for consideration, the intention being that the Committee of Eight shall at the earliest possible moment present to The Engineering Institute of Canada a suggested basis for co-ordination. In view of the inexpediency of holding a meeting of the Committee of Eight at this time, such negotiation shall be conducted by correspondence.

The "Questionnaire" of the Committee on Consolidation is being considered by the Corporation but the results of its deliberations thereon have not yet been received.

Province of Ontario

Ottawa Branch (297)

The Ottawa Branch made the following returns on the "Questionnaire":

Question No. 1.—Yes.
Question No. 2—Yes. If this is impossible of attainment at the present time we would not be in favour of allowing it to prevent or delay steps toward consolidation. Further, provided that some provision will be made for those members of The Institute residing outside of Canada or those whose official position does not require affiliation with a provincial organization.
Question No. 3—Yes.
Question No. 4—Yes. With variable fee according to the extent which the individual member would require a provincial license.
Question No. 5—Yes. But the function of admission to membership in the National organization might be taken over not at once but gradually, by the Provincial organization as a common understanding of the standard necessary for membership will become more generally comprehended in the various provinces. The collection of fees might be taken over by the Provincial organizations from the beginning.

Peterborough Branch (43)

This Branch answered the "Questionnaire" as follows:
Question No. 1—Yes, 17; No, 0.
Question No. 2—Yes, 17; No, 0.
Question No. 3—Yes, 17; No, 0.
Question No. 4—Yes, 17; No, 0.
Question No. 5—Yes, 13; No, 4.

Kingston Branch (29)

This Branch made the following return on the "Questionnaire":
Question No. 1—Yes.
Question No. 2—Yes, but with exceptions for
(*a*) Engineers from other countries.
(*b*) Engineers now members of The Institute who do not wish to join their Professional Association.
Question No. 3—Yes.
Question No. 4—(How much would the fee be?)
Question No. 5—Dues—Yes. (If a single fee is adopted.)
Admission—No.
Discipline—No — insofar as the rules of Ethics are concerned.

Toronto Branch (317)

The Toronto Branch has issued the "Questionnaire" to its members for an expression of their individual opinions. This Branch favours a Joint Committee of the Branches of The Institute in Ontario to meet a Joint Committee of the Association of Professional Engineers of Ontario to discuss the question of "Consolidation of the Engineering Profession in Canada."

The Branch has appointed the following Special Committee—Messrs. O. Holden, W. E. Bonn, and C. E. Sisson, Chairman.

The following are the results of the "Questionnaire" issued to the members of this Branch for an expression of their individual opinions:
Question No. 1—Yes, 128; No, 3.
Question No. 2—Yes, 117; No, 10.
Question No. 3—Yes, 119; No, 5.
Question No. 4—Yes, 122; No, 3.
Question No. 5—Yes, 109; No, 15.

Fifteen of the above members submitted suggestions, explanatory remarks or questions.

Hamilton Branch (79)

The Hamilton Branch has made the following return on the "Questionnaire":
Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes, if reorganization takes place.
Question No. 4—Yes.
Question No. 5—Yes, if approved by the National Governing Body.

Mr. H. A. Lumsden is chairman of the Special Committee on Consolidation and representative of the Branch on the Provincial Committee on Consolidation.

London Branch (38)

The "Questionnaire" was issued to the members of this Branch for an expression of their individual opinions and the results were as follows:
Question No. 1—Yes, 19; No, 0.
Question No. 2—Yes, 18; No, 0.
Question No. 3—Yes, 17; No, 1.
Question No. 4—Yes, 18; No, 0.
Question No. 5—Yes, 16; No, 3.

Niagara Peninsula Branch (75)

The Niagara Peninsula Branch has replied to the "Questionnaire" as follows:
Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes.
Question No. 4—Yes.
Question No. 5—Yes.

Border Cities Branch (50)

The Border Cities Branch made the following return on the "Questionnaire":
Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes.
Question No. 4—Yes.
Question No. 5—(Left unanswered)

Sault Ste. Marie Branch (55)

The Sault Ste. Marie Branch issued the "Questionnaire" to its membership for an expression of their individual opinions and the results are as follows:
Question No. 1—Yes, 28; No, 1.
Question No. 2—Yes, 28; No, 1.
Question No. 3—Yes, 28; No, 1.
Question No. 4—Yes, 29; No, 0.
Question No. 5—Yes, 18; No, 11.

Lakehead Branch (34)

The replies to the "Questionnaire" from this Branch are as follows:
Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes.
Question No. 4—Yes.
Question No. 5—Yes.

Association of Professional Engineers of the Province of Ontario (1,119)

The Association appointed the following Special Committee to consider the Problem of Co-ordination:—Messrs. Archie B. Crealock, E. M. Wood, E. R. Frost and J. Clark Keith, Chairman.

The report of this Committee was accepted by the Association with some minor reservations:
Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes.
Question No. 4—Yes.
Question No. 5—Yes.

Province of Manitoba

Winnipeg Branch (131)

The Winnipeg Branch of The Institute has appointed the following Special Committee on Consolidation:—Messrs. C. H. Fox, C. H. Attwood, J. W. Sanger, Fred. V. Seibert, E. V. Caton, Secretary, and A. J. Taunton, Chairman.

The "Questionnaire" was issued to the members of the Branch for an expression of their individual opinions and the results are as follows:
Question No. 1—Yes, 57; No, 0.
Question No. 2—Yes, 53; No, 4.
Question No. 3—Yes, 55; No, 2.
Question No. 4—Yes, 53; No, 4.
Question No. 5—Yes, 49; No, 8.

Eight of the above members submitted suggestions, explanatory remarks or questions.

Association of Professional Engineers of the Province of Manitoba (*203*)

The Association has a Special Committee co-operating with the Special Committee of the Winnipeg Branch, forming a Joint Committee on Consolidation in this Province. In view of the progress of the deliberations of the Joint Committee, and the proposals relative to Consolidation within the Province, which it has drawn up for submission to both organizations, the Association has refrained from answering the "Questionnaire" until these proposals have been passed upon by the engineers of Manitoba. It is anticipated that a decision will be made in the near future.

These proposals are as follows:

1. The Council of The Institute will recognize registration with the Association as constituting full and satisfactory qualifications for admission to the grade of member in The Institute.
2. The Association will acquire a group membership in The Institute by virtue of which each and every individual shown on the register of the Association will be a member of The Institute.
3. The Association will pay annually to The Institute a group membership fee.
4. The annual fee for members may, if necessary, be increased to cover the increased activities of the group membership.
5. The Association of Professional Engineers of the Province of Manitoba shall assume the functions of the Winnipeg Branch of The Institute.
6. Individuals who are not practising engineering within the meaning of the Act may, if they are qualified and accepted, obtain or continue membership in The Institute and pay their fees direct to headquarters. The Association will extend to such members the privilege of attending and participating in all meetings, but they will not be qualified to vote in such meetings.

The above proposals were approved by the executive of the Professional Association on September 16th and by the executive of the Winnipeg Branch E.I.C. on September 26th, 1935.

A joint General Meeting of the members of the Winnipeg Branch and the Association of Professional Engineers of the Province of Manitoba, will be held at the University of Manitoba on Thursday, November 7th, to receive and discuss the above recommendation of the Joint Committee, after which a letter ballot will be sent out to the members of both organizations.

Province of Saskatchewan

Saskatchewan Branch (*64*) *and Association of Professional Engineers of the Province of Saskatchewan* (*89*)

The consideration of the problem of Consolidation is well advanced in this Province under a Special Joint Committee of the Branch and the Association of which Mr. D. A. R. McCannel is Chairman. The engineers of this Province were the first to make a return on the "Questionnaire" and the results were as follows:

Question No. 1—Yes.
Question No. 2—Yes.
Question No. 3—Yes.
Question No. 4—Yes.
Question No. 5—Yes.

A General Meeting of the engineering profession in Saskatchewan was held as an open meeting of the Professional Association of that Province in Regina, on October 26th, 1935. At this General Meeting the following Resolutions were passed without a dissenting vote:—

1. Resolved that this General Meeting of the Engineering Profession in Saskatchewan endorses the general principle of Consolidation of the Engineering Profession in Canada, and urges the Executive of respective Engineering societies to overlook minor details and make every effort to consummate Consolidation.
2. Resolved that this General Meeting of the Engineering Profession in Saskatchewan hereby goes on record as considering National Consolidation the objective of the Profession, but if a National scheme is not formulated within six months, that we consider it the duty of National societies to take immediate steps to permit Consolidation in any Province desiring such action.
3. Resolved that this General Meeting of the Engineering Profession in Saskatchewan, from reports received, deplores the apparent lack of action by the Dominion Council of Professional Associations, and hereby goes on record to request the Council of the Association of Professional Engineers of Saskatchewan to take the necessary steps to urge such Associations to arrange for a National meeting at an early date to give consideration to the Consolidation of the Engineering Profession in Canada.
4. Resolved that this General Meeting of the Engineering Profession in Saskatchewan further requests that the Council of the Association of Professional Engineers of Saskatchewan notify all interested parties of the foregoing resolutions and further, that they supply Saskatchewan Engineers with a digest of the Papers presented at this meeting, and a copy of the Resolutions adopted.

Province of Alberta

Lethbridge Branch (*24*)

While this Branch of The Institute has gone on record as being in favour of Consolidation, they did not fill in the "Questionnaire" as they feel this matter should be dealt with through the "Dominion Council of Engineering."

Edmonton Branch (*45*)

The Edmonton Branch issued the "Questionnaire" to its members for an expression of their individual opinions with the following results:

Question No. 1—Yes, 12; No, 0.
Question No. 2—Yes, 11; No, 1.
Question No. 3—Yes, 12; No, 0.
Question No. 4—Yes, 11; No, 0.
Question No. 5—Yes, 7; No, 3.

Certain of the answers carried qualifications. This Branch has suspended further action on this matter, pending consideration of a proposal by the Calgary Branch for a provincial conference of representatives of the Branches of the E.I.C. and the Provincial Professional Association.

Calgary Branch (*73*)

The Calgary Branch appointed the following Special Committee on Consolidation:—Messrs. John Haddin, Lieut.-Colonel F. M. Steel, G. P. F. Boese, S. G. Porter and R. S. Trowsdale, Chairman. The Calgary Branch made the following reply to the "Questionnaire":

Question No. 1—Yes.

Question No. 2—Yes; (*a*) Providing the present corporate members of the E.I.C. should continue to be corporate members of the national organization. (*b*) We suggest that the members of the Provincial Association of Professional Engineers be admitted to the E.I.C. and that all E.I.C. members be admitted to the provincial Association. (*c*) That those members of the E.I.C. who do not wish to be registered be allowed to remain as corporate members of the National Association.

Question No. 3—Yes.

Question No. 4—Yes, providing as in question 2 (*c*) E.I.C. members may continue to pay fees to the national association in the event that they do not see fit to register with the provincial association.

Question No. 5—Yes.

Association of Professional Engineers of the Province of Alberta. (*253*)

The whole question of Consolidation and the "Questionnaire" will be considered by this Association on November 2nd, 1935.

Province of British Columbia

Vancouver Branch (*127*)

This Branch has submitted a Report prepared by Mr. P. H. Buchan, past-chairman of the Vancouver Branch, as representing views of that Branch on Consolidation. This Report has been printed in full in the August issue of The Journal. The Committee on Consolidation has not attempted to interpret the Report in the terms of the "Questionnaire."

Victoria Branch (*45*)

The Victoria Branch submitted a "Questionnaire" to its members for an expression of their individual opinions. The results are as follows:

Question No. 1—Yes, 18; No, 0.
Question No. 2—Yes, 17; No, 1.
Question No. 3—Yes, 17; No, 1.
Question No. 4—Yes, 18; No, 0.
Question No. 5—Yes, 16; No, 2.

Two of the above members submitted suggestions, explanatory remarks or questions.

The Branch strongly favoured the Consolidation of The Engineering Institute of Canada and the Provincial Associations of Professional Engineers and the appointment of a Joint Committee of the Branches of The Institute in British Columbia to discuss Consolidation with a Committee of the Association of Professional Engineers in that Province.

Association of Professional Engineers of the Province of British Columbia (*808*)

This Association has previously decided to refer the whole matter (of Consolidation) to the Committee of Eight and to leave any action until the advice of the Committee of Eight has been received. It is reported that the Council of the Association is at present considering what further action may be taken. It might be noted that the Committee of Eight held its last meeting in February of 1933.

*Note:—The figures in parentheses give the approximate number of active corporate members of The Institute in the branches concerned and the membership of the various Professional Associations.

Gordon McL. Pitts, A.M.E.I.C.,
Chairman, Committee on Consolidation.

BRANCH NEWS

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

An Engineer's Experiences in Russia

The Hamilton Branch of The Engineering Institute of Canada were guests of the Ontario Chapter of the American Society for Metals at their regular meeting, October 11th, 1935, at the Royal Connaught hotel.

The speaker of the evening, Arthur G. McKee of the McKee Construction Company, chose as his subject "An Engineer's Experiences in Russia" and was introduced by Prof. O. W. Ellis of the Ontario Research Foundation.

Mr. McKee's company was under contract with the U.S.S.R. to build, at Magnetogorsk in the mid-southern territory, a complete steel works from blast furnaces to rolling mills. It was typical of Russian phsychology that their constant theme was "haste" and "hurry," with a constant check on schedules set up for the work.

The plant was a huge affair and the coal and necessary ore were separated by 1,500 miles of single track of 70 pound rail—and it may be imagined that deliveries were slow. It was necessary to dam the Ural river to provide adequate water for plant operation during the whole year and to build a skid dam 34 feet high on silt.

Blast furnaces had 25-foot hearths, were 100 feet in height, stoves 28 feet by 140 feet high, with as much as 200,000 square feet of heating surface and blowers producing 115,000 cu. ft. at 30 pounds per square inch. The Russians did not follow instructions implicitly, and redesigned the hearths of the blast furnaces and would not use the proposed switching designs.

In Russia there is a natural inertia to change whether it be living conditions, working conditions, or social life. Cranes provided for erection of steel and concrete work were discarded for great forests of timber erection. In Russia "Everybody lifts, and everyone sweats." Women as well as men must work to eat. The children are brought up to believe in no god but themselves and Russia. What effect this teaching will have upon the new generation can only be guessed.

Mr. W. Hollingworth, M.E.I.C., made a motion of a vote of thanks to Mr. McKee, but the applause of the assembly showed that no seconder or voting was necessary to show their approval.

About 200 were present, many from out of town, and prior to the meeting there was an informal dinner. Mr. A. B. Oram, chairman of the Ontario Section A.S.M., presided at both dinner and meeting.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

Smoker

A well-organized and exceptionally well-attended informal smoker held in the Rose Room of the Windsor hotel on Friday evening, October 4th, 1935, ushered in the nineteenth season of activities of the Montreal Branch. F. S. B. Heward, A.M.E.I.C., chairman of the Branch, acted as chairman, and Dr. F. A. Gaby, president of The Institute, was the guest of honour.

Songs, music and choruses enlivened the proceedings while the programme also included recitations and sleight-of-hand tricks, the contributors being D. C. Tennant, M.E.I.C., who led the community singing, F. Cleal, orchestra conductor, Noble Birks, R. Eric, Crawford, A.M.E.I.C., J. L. Heald, W. J. Langston, J. G. Caron, A.M.E.I.C., R. H. Findlay, M.E.I.C., F. J. McHugh, A.M.E.I.C., Professor C. M. McKergow, M.E.I.C., and others. Many of the artists were members of The Institute.

During the course of the evening refreshments were served, and Mr. Heward made a brief address, as did Dr. Gaby, and introduced a number of guests including four Past-Presidents of The Institute who were present: Messrs. G. H. Duggan, M.E.I.C., H. H. Vaughan, M.E.I.C., Dr. O. O. Lefebvre, M.E.I.C., and F. P. Shearwood, M.E.I.C.

The attendance of 325 almost equalled that of the smoker held last spring.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

For the first meeting of the season this Branch visited the McKinnon Industries of St. Catharines, a branch of the General Motors, where small parts are manufactured for Canadian and Empire trade.

This factory exemplifies the evolution in business during the last fifty years. Started about the year 1880, by Messrs. L. E. McKinnon and F. F. Mitchell of St. Catharines, as a saddlery and waggon hardware factory, the business was extended to cover carriage dashes and fenders. The malleable iron foundry was constructed in 1901 and a drop forging department opened in 1905 when the manufacture of chain was undertaken. A separate factory was built at Tonawanda, N.Y., and, in 1917 the chain company was merged with the Columbus Chain Co., of Columbus, Ohio.

At the outbreak of the war the St. Catharines plant secured large contracts from the British and French governments for military harness hardware. In 1916 the plant was extended to provide for the manufacture of shrapnel bullets, time fuses and H.E. shells.

After the war, machinery was installed to manufacture automobile radiators, differentials and transmission gears, the first venture of that nature in Canada.

Late in 1928 the General Motors opened negotiations for the purchase of the plant and, on March 1st, 1929, that corporation assumed control and became owners of the McKinnon Industries Limited through an exchange of stock.

Since then the plant has been extended and improved. A pulverized coal system has been installed and a modern building erected to manufacture Delco-Remy equipment which, up to that time, had been imported from Anderson, Indiana.

The chief products of the plant are now as follows: malleable iron castings, steel forgings, differentials, shock absorbers, steering gears, starting motors, generators, ignition coils, spark plugs, rear axle shafts, fractional h.p. motors for electric refrigeration, and various tools. Units for six hundred cars a day can be supplied. Some twelve hundred men are employed with a yearly payroll of about three quarters of a million dollars. A modern foundry lay-out, with a system of travelling conveyors for the moulds and continuous pouring, is now being designed.

After a well attended dinner at the Welland House, Mr. Orwell Brown, factory manager, explained that the automotive industry is not only seasonal but has large yearly fluctuations. The effect of a poor season is less noticeable in a community with diversified manufacturing interests than it would be if all work were concentrated in a single city such as Oshawa.

A lengthy discussion followed and the skeleton sections of various products were examined with great interest.

Walter Jackson, M.E.I.C., proposed the vote of thanks to Mr. Brown, his assistants and the General Motors for their kindness in providing an instructive afternoon and evening session. Chairman Paul Buss, A.M.E.I.C., then declared the meeting adjourned.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

Le Cout d'Exploitation des Centrales Diesel

Tel fut le sujet traité à une réunion générale des membres de la section de Québec, par M. Jean St-Jacques, S.E.I.C., assistant ingénieur au Quebec Power.

L'étude du conférencier s'est limitée aux petites centrales de 500 chevaux ou moins localisées dans la ville de Québec; une série de résultats obtenus dans 18 centrales établies aux Etats-Unis fut d'abord présentée, puis leur coût d'exploitation fut ramené aux conditions existant à Québec quant au prix du combustible.

Ces exemples ont montré jusqu'à quel point le coût d'exploitation dépend du facteur d'utilisation et que l'on doit bien se garder de parler de résultats moyens. Il fut aussi démontré que le moteur Diesel a un bon rendement économique quand il est chargé à sa puissance normale mais que ce rendement baisse rapidement quand on le surcharge ou qu'on le charge seulement à une fraction de sa puissance nominale; de cette dernière constatation le conférencier conclut qu'il y a nécessité d'établir avec précision la puissance requise dans un projet quelconque.

Le conférencier montra ensuite une analyse des résultats obtenus dans une centaine de centrales Diesel établies en Angleterre et en Amérique; de cette analyse il est possible d'établir des courbes du coût des divers éléments qui entrent dans le coût total d'exploitation. Ces divers éléments sont ensuite combinés de manière à obtenir un coût total pour toute une série de facteurs d'utilisation en supposant que la centrale fonctionne à pleine charge aux heures de pointe. Ces résultats s'expriment sous forme de courbes en regard desquelles il est possible de mettre d'autres courbes donnant le coût d'achat de l'énergie électrique au réseau de distribution à Québec.

Comme conclusions générales le conférencier démontre qu'à des facteurs d'utilisation réduits le prix de production de l'énergie par groupes électrogènes se rapproche beaucoup du prix d'achat de l'énergie au réseau de distribution. De même pour des facteurs élevés le coût unitaire au kwh. est bas et il augmente à mesure que le facteur d'utilisation diminue. Enfin il est démontré par l'écart de prix entre le coût à l'utilisation élevée et le coût à utilisation réduite que tout projet de centrale Diesel nécessite une étude approfondie des conditions d'exploitations afin d'établir le facteur d'utilisation de l'installation.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

A Philosophical View of the World Today

On October 3rd, 1935, Professor Rupert C. Lodge, M.A., Professor of Logic and History of Philosophy of the University of Manitoba, presented a paper, "A Philosophical View of the World Today," at the initial fall meeting of the Branch.

Professor Lodge stated that there are three major viewpoints of philosophy, realism, idealism and pragmatism, each of which to some extent contradicts the others. The realist thinks of the world of physical reality as being primary. The idealist believes that man's mind transcends the physical. The pragmatist believes that the two preceding types go well beyond the facts, that the proper attitude is to stay rooted in experience. The present day realist regards the mind as the interaction of the physical senses with environment. He looks out on the world today expecting the worst, and believing that present tendencies confirm his idea that the world is barbaric as ever. The idealist looks on the present world and is pessimistic, for he wishes to see his ideals realized. The pragmatist believes that we are biological and social organisms. He claims he is more real, more concrete, than the realist. His gaze is on the problems of the moment, he has no use for history, he minds his own business.

These three viewpoints are tendencies within ourselves which come into conflict when we form our judgments, though usually one of them is stronger than the others. It has been said that Goethe is the best example of a happy combination of all three.

Those taking part in the discussion which followed included T. C. Main, A.M.E.I.C., W. D. Hurst, A.M.E.I.C., G. E. Cole, A.M.E.I.C., and W. F. Oldham, A.M.E.I.C. A vote of thanks was moved by Professor A. E. McDonald, A.M.E.I.C., after which the meeting adjourned for light refreshments.

The Consolidation Problem

Comments on the Memorandum by P. L. Pratley, M.E.I.C. (published in the July issue of The Journal, pages 359-360), prepared by E. A. Wheatley, M.E.I.C., Registrar, Association of Professional Engineers of British Columbia.

(*Underlining by Mr. Wheatley*)

Quotation

"Any serious effort to solve the problem... must be based upon the recognition of certain fundamental facts..."

"Admittedly the meaning of 'profession' may be revised or redrafted or stretched... but basically... the essence of the idea is the personal contact between the 'professor' and his client whether he be lawyer, doctor, or dancing master."

Comment

Definitely inaccurate. Consideration of all the other professions will prove its inaccuracy. The young priest when ordained, the young lawyer on being called to the Bar, the young doctor, the young architect, the young chartered accountant, on receiving their licences, may and invariably do continue in an employee capacity for many years before making "personal contact" with clients. In law lawyers continue for many years in an employee condition and officially and authoritatively quite 40 per cent of the legal profession continue indefinitely in an employee condition. Making personnal contact with clients is but accidental and secondary, and is not the fundamental idea of what constitutes a professional man which is:—

Originally, a professional man was one who 'professed' a special education and special training. By the passage of time and the seal of custom, it is now one who has passed through an *officially* prescribed education, an *officially* prescribed junior experience and passed official tests, and thus is one who is *officially* authorized "to profess." Personal contact is nowhere stipulated.

The official authorization in all professions on this continent is the licence to practise.

One can visualize or recognize the inaccuracy of Mr. Pratley's proposals by contemplating imaginatively the lot of an engineer brother amongst a group of brothers belonging to the other professions. At a young age of from 25 to 30, the oldest brother is ordained as a priest, the second brother is called to the Bar, the remaining brothers have received a license as a doctor or as an architect or chartered accountant. At a reunion of the family all will be congratulating those other brothers on having received formal official recognition by their respective professions, but the engineer son, a graduate and an engineer of many years junior experience, one who in British Columbia, would have passed the final test and would have written a book or thesis (of all mental tests the most difficult), to this young professional man, the brothers and parents would turn and inquire why he should not have received the highest honour at the disposal of his profession. He could only reply. "Oh no. I have gone through an officially prescribed disciplinary period as my brothers have, but Mr. Pratley states that 'it is totally inapplicable' for me to receive a license to practise. I must wait until I 'make personal contact with clients' before I can receive my license."

Quotation

"A large majority... of engineers... in cities are... employees of corporations and industrial firms, [(to these)] the licensing idea is totally inapplicable." "In the Provinces, the provincial organizations are regarded [(by engineers)]... as a type of trade union, in no sense valuable to the public and only useful... as they limit the number of entrants or applicants for employment."

Comment

The number of industrial engineers who have sacrificed their time to work on the Councils of the Association in B.C. and on the other hand the number of leading Government and municipal engineers who have also worked as presidents and on the Councils of the Association in B.C. proves the injustice and inaccuracy of these words and condemns them and their author.

Industrial engineers in B.C. prove that it is *not* "totally inapplicable" to licence the young assistant engineers. In B.C. *they delight* to reward merit by confining employment or granting a strong preference to the young licensed engineer and to the young enrolled student—no compulsion, whatsoever,—the young engineer *longs* for his license, and the industrial employer *delights* to reward him and *give value* to the license, by employing or promoting him.

Quotation

"And only a certain few should be compelled to apply for a license."

Contrast this with the quotation

"The qualification should definitely include corporate membership in the national Institute."

Comment

In B.C. we should have to reduce our members from 824 to possibly 206 requiring the remaining 618 to list merely their names ("both registered engineers and graduate engineers would be voluntary listees with the Committee"), also too, our 520 students would be expected presumably to leave the Association and to join The Institute.

One can justifiably criticise Mr. Pratley for selecting a passion-raising word such as "compelled" or "compulsion"—it is provocative.

Note:—He would use the very powers of the Associations which he tacitly condemns by his use of the word "compulsion," to compel professional engineers to seek membership in The Institute, but he uses the much quieter terms of "definitely include"—and later he uses even the non-provocative terms "reasonably be required."

Quotation

"The graduate engineer might reasonably be required to become a corporate member of the national body."

"As to the accomplishment of this new consolidation... the principal requirement is the 'will'."

Comment

It is required of the Association to have the "will" to degrade the Associations, not so much to merge them, but to submerge them, and in B.C. we must have the "will" to give up 618 members,—to lose our name, etc. etc. Would any organizations of any type whatsoever agree to negotiations leading almost to such complete submerging?

Quotation

[(Associations will)] "of necessity surrender this extreme and logically untenable position in favour of the logical attitude that a certain well-defined group of engineers who... receive licenses," a chosen few.

Comment

There is no need for further comment on this. Such an idea is totally contrary to the philosophy of *all* registration acts (already dealt with on Page One of this memorandum.)

Quotation

"It is quite possible that alterations to some of the existing acts would ultimately be required but... there would not seem to be any overwhelming reason ... and the alteration in the acts delayed until two or three years."

Comment

The administrators of the Acts have a duty to perform to the Governments who granted their Acts and any Association which contemplated operating their Acts *illegally* for two or three years, would deserve to have the Act repealed.

Quotation

"The proposal... has the further value that The Institute can keep open its doors to all those worthy contributors to the progress of engineering who may never reach professional status."

Comment

Does the Canadian Medical Association grant membership to orderlies, because they are "worthy contributors to the progress of medicine?" Does the Canadian Bar Association open its ranks and grant membership to hack law clerks or male stenographers on the plea that they are "worthy contributors to the progress of law?" Does the Architectural Institute of Canada open its doors to draftsmen on the same fallacy? No. The national body of all of the professions is and must be a *rigidly strictly professional body.*

Vancouver, B.C. E. A. W.
September, 1935.

(*Note:*—The above analysis was accompanied by a proposal to hold a meeting of the Presidents and Secretaries of all the Provincial Professional Associations and the members of the Committee of Eight in Montreal, in January 1936, to determine the basic principles on which Consolidation can be effected from the point of view of the Provincial Professional Associations.)

Preliminary Notice

of Applications for Admission and for Transfer

October 31st, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in December, 1935.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

BOYD—DAVID, of 6-36th Avenue, Lachine, Que., Born at Belfast, Ireland, Sept. 15th, 1902; Educ., B.Sc. (E.E.), McGill Univ., 1928; With Dominion Bridge Co. Ltd., as follows: 1923-29, dftsman and checker; 1929-33, mtce. supt.; 1933 to date, asst. works manager.

References: F. P. Shearwood, F. Newell, H. W. McMillan, A. S. Wall, C. V. Christie.

GODDARD—HAROLD OLIVER, of Montreal, Que., Born at Montreal, Aug. 26th, 1906; Educ., B.Sc., McGill Univ., 1928; 1923-24, elevator repair helper, Henry Morgan & Co. Ltd.; Summers: 1925, clerk, C.N.R., 1926, tracer, Northern Electric Co., 1927, and May 1928 to May 1929, dftsman and pump tester, Charles Walmsley & Co. (Canada) Ltd.; 1929 (May-Aug.), dftsman and pump tester, Dominion Engrg. Works Ltd.; 1929-30, foreman in mechl. operating dept., Laurentide Divn., 1930-32, dftsman and junior engr., Belgo Divn., 1932 (May-Aug.), log pile surveys, Laurentide, Belgo and Wayagamack Divns., Consolidated Paper Corpn.; July 1932 to date, engr. on research, estimates, dfting and supervision of constrn., Nichols Engineering and Research Corpn. of Canada Ltd., Montreal, Que.

References: A. R. Roberts, C. E. Herd, G. Claxton, E. B. Wardle, C. Thomson, W. B. Scott, H. E. Bates, C. U. R. Vessot.

KINGHORN—HAYWARD COBURN, of 1043 Patrick St., Victoria, B.C., Born at Fredericton, N.B., Oct. 9th, 1886; Educ., B.Sc. (Forestry), Univ. of N.B., 1911; 1910-12, forest asst. in B.C.; 1912-15, forest asst., B.C. Forest Branch; 1915-19, overseas, Lieut., Can. Engrs.; 1919-20, forest asst. with the N.B. Forest Service; 1920-22, forest engr., C.P.R., Dept. Natural Resources, in B.C.; 1922-23, forest engr., timber estimating, in B.C., for Ryan-Hibbarson Timber Co., Victoria, B.C.; 1923-29, private forest engrg. business, Cranbrook, B.C.; 1929-31, forest engr., in charge of timber survey in connection with the survey of resources of the P.G.E. Rly. lands in Northern B.C., ground and aerial surveys; 1931-33, private practice as consltg. forester and general forestry work in B.C.; 1933 to date, asst. engr., Dept. National Defence, on highway projects and emergency landing fields in M.D. No. 11, British Columbia.

References: F. C. Green, H. L. Swan, O. W. Smith, E. C. G. Chambers, C. R. Crysdale.

MacMILLAN—DOUGLAS CLAYTON, of 11 Peter St., Port Arthur, Ont., Born at Midland, Ont , July 23rd, 1901; Educ., Private study and corres. course in reinforced concrete engrg.; 1918-27, with the Midland Shipbuilding Co., Midland, Ont., as follows: 1918-23, ap'ticed as ship dftsman.; 1923-25, ship dftsman.; 1925-27, designer on all types of lake freighters, tugs, scows, water tanks and hoisting booms; 1927-32, with C. D. Howe & Co., Port Arthur, Ont., on layout, design and checking design on all types of wooden, steel and reinforced structures connected with grain elevators; field engr. on constrn. of grain elevator and power house at Churchill, Man.; 1932-34, intermittently with Dept. of Public Works, Ottawa, as inspr. on constrn. of a rubble mound breakwater at Port Arthur, and with the Ontario Dept. of Northern Development, as asst. engr. on highway location and constrn.; 1934-35, with Dept. of Northern Development, Port Arthur, as office engr. on layout and mtce. of township roads, layout and design of timber and concrete bridges; at present, engr. on grain elevator design, C. D. Howe & Co., Port Arthur, Ont.

References: C. D. Howe, R. B. Chandler, P. E. Doncaster, J. M. Fleming, G. R. McLennan.

McLENNAN—DUNCAN OSBORNE, of Ottawa, Ont., Born at Ottawa, April 11th, 1905; Educ., B.Sc., (Forestry), Univ. of N.B., 1931; 1923-24, rodman, Riordon Co.; 1924-25, instr'man., 1925, pile inspr., 1926-27, tower inspr., Candn. International Paper Co ; 1928-29 (summers), asst. to woods supt., The Bronson Co.; 1930 (summer), asst. forest engr., and 1931 to date, forest engr., E. B. Eddy Co. Ltd., Hull, Que.

References: H. Kennedy, F. E. Bronson, C. M. Pitts, W. S. Kidd, G. R. Turner.

PATERSON—JAMES WILSON, of Ottawa, Ont., Born at Glasgow, Scotland, Sept. 9th, 1896; Educ., 1912-14, and 1928-29, Royal Technical College, Glasgow; 1912-14, shop training, St. Rollox Loco. Works, Glasgow; 1917, Imperial Munitions Board, gauges and standards, Ottawa; 1917-28, woods dept., J. R. Booth, Ltd., Ottawa. Various capacities, finally as district woods supt.; 1929, dftsman. and surveyor, engrg. dept., and from 1929 to date, asst. woods manager, E. B. Eddy Co. Ltd., Hull, Que.

References: H. Kennedy, W. S. Kidd, A. N. Ball, F. M. Pratt.

RIVARD—JEAN GUALBERT, of Ottawa, Ont., Born at Les Grondines, Que., Aug. 19th, 1903; Educ., Forestry Engr., Forestry School, Laval Univ., Quebec, 1926; 1926-29, land surveying, levelling, Henri Belanger, Q.L.S.; 1929-30, forestry engrg., Quebec Forestry Service; 1930 to date, land surveying, aerial survey, forest mensuration, and forest surveys in general, and at present chief forest engr., E. B. Eddy Co. Ltd., Hull, Que.

References: H. Kennedy, P. Joncas, W. S. Kidd, A. N. Ball, G. Stephenson.

SCOTT—LEWIS JOHN, of Grand Falls, Nfld., Born at St. John's, Nfld., Sept. 4th, 1900; Educ., B.Sc , McGill Univ., 1923; 1923-24, erection shop, 1924-25, dftsman., Dom. Engrg. Works, Lachine; 1925-26, dftsman., Charles Walmsley & Co., Bury, Lancs.; 1926-30, asst. engr., engrg. dept., 1930-35, in charge of control statistical office, and at present, asst. purchasing agent, Anglo-Newfoundland Development Co., Grand Falls, Nfld.

References: G. F. Hardy, C. M. McKergow, H. S. Windeler, F. M. Pratt, J. J. O'Sullivan.

SOMERVILLE—ARCHIBALD LAURENCE HAROLD, of Calgary, Alta., Born at Winnipeg, Man., Aug. 30th, 1898; Educ., B.A.Sc. (Mech.), Univ. of B.C., 1923. R.P.E. of B.C.; Various positions during college vacations; 1924-27, engr. on design of C.P.R. Pier B-C, Vancouver; 1927-28, field engr. inspr. and res. engr. on terminal grain elevator constrn. for C. D. Howe & Co. Ltd., Port Arthur, Ont.; 1928-33, res. engr. on public bldgs., terminal docks, etc., for Pacific Engineers Ltd., of Vancouver: With Dept. of National Defence as follows: 1933-34, asst. engr., group hdqrs., Nelson, B.C., on highway constrn. and landing field constrn.; 1934 to date, engr., district hdqrs., Calgary. Supervision of highway and intermediate landing field constrn., constrn. of camps, estimates, purchasing, etc. (Unemployment relief).

References: P. F. Peele, C. D. Howe, E. A. Wheatley, J. P. Coates, R. S. Trowsdale.

WATERS—ALLAN JAMES, of Vancouver, B.C., Born at Forest Row, Sussex, England, Oct. 19th, 1866; Educ., 1882-85, articled pupil to registered architect and engineer at East Grinstead, Sussex; 1886-1890, improver, District Board of Works, Lewisham, England; 1890-92, London Metropolitan Board of Works, Wandsworth District; 1892-96, dftsman., civil engrg. dept., H.M. Naval Yard, Devonport, England; 1896-98, officer in charge of works dept., H.M. Naval Yard, Halifax, N.S.; 1898-99, Admiralty Head Office, London, England; 1899-1902, civil engr. in charge, Island of Ascension, W. Africa; 1903-04, civil and mining engr., South Africa; 1904-06, engrg. dept., Johannesburg Municipality, S. Africa; 1906-07, harbour works, Ferro Concrete Co. of Australia, Melbourne; 1907-09, engrg. dept., Auckland City Council, New Zealand; 1909-12, sewerage system, waterworks, etc., Nanaimo, B.C.; 1912-16, Prov. Govt. of B.C., Victoria; 1916-19, British Admiralty on war service, asst. engr. on harbour works at Scapa Flow, and later on aeronautical inspection duties; 1919-21, installn. of addition to plant, B.C. Electric Power and Gas Co.; 1921-22, engrg. work, Municipality of Seattle, Wash.; 1924-28, representing and supervising works in Arizona and California for Myron Hunt and Chamber, Archts. and Engrs., Los Angeles; 1930-34, supervising erection of new plant, B.C. Electric Power and Gas Co.; at present, asst. engr. on appraisal, B.C. Electric Rly. Co., Vancouver, B.C.

References: W. G. Swan, A. C. Eddy, P. H. Buchan, C. E. Cartwright, E. A. Cleveland, W. H. Powell.

WORLD—HARRY P., of Toronto, Ont., Born at Toronto, Aug. 10th, 1904; Educ., 1919-24, Toronto Technical School; Private reading and research; 1919-24, dftsman., plant mtce., Consumers Gas Co., Toronto; 1924-26, dftsman. and rodman, Toronto, and 1926 (Mar.-Sept.), transitman and dftsman., London, C.P.R.; 1926-27, dftsman. and transitman, McColl Bros. Ltd., Toronto; 1927 (Mar.-Sept.), transitman and dftsman., C.P.R., London, Ont.; 1928-31, with Ross & MacDonald, Architects, Montreal, as asst. supt. and supt. on various constrn. jobs, including the Royal York Hotel, and Eaton's College St. store, Toronto; 1932, supt. on constrn., Burroughs Bldg., London, Ont., for E. F. Wright, Toronto; 1932-34, asst. job. engr., constrn. of Victoria Park filtration plant for City of Toronto, for Northern Constrn. Co. Ltd., and J. W. Stewart Ltd.; 1934-35, dftsman., bldg., alterations, property dept., City of Toronto; at present, res. engr., representing Col. Mackenzie Waters, supervising architect, on constrn. of Customs Bldg. addition, Toronto, Ont.

References: A. R. Holmes, B. Ripley, V. A. G. Dey, C. R. Redfern, P. N. Gross, R. W. Willis, W. J. Armstrong, E. A. H. Menges.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

WALKER—JAMES ALEXANDER, of 5612 Laval Road, University Hill, Vancouver, B.C., Born at Guelph, Ont., Aug. 6th, 1887; Educ., Diploma, C.E., 1908, B.A.Sc., 1910, Degree of C.E., 1926, Univ. of Toronto; B.C.L.S., 1912; R.P.E. of B.C.; 1903-04 (summers) and 1905, city engr's office, Guelph, Ont.; 1906 (summer), asst. with Chataway & Jephson, Winnipeg, Man.; Summer 1907 and 1909, and May 1910 to Jan. 1911, land surveying, etc., at Nelson, B.C.; Summer 1908, Yukon Gold Co., Dawson, Y.T.; 1908-09, Fellow in surveying and drawing, Univ. of Toronto; 1911 (Feb.-Apr.), city engr's office, Moose Jaw, Sask.; 1911-12, chief examiner of survey notes, Dept. of Lands, Victoria, B.C.; 1912, in charge of land survey for Prov. Govt., Fort George, B.C.; 1912-13, land surveying, city surveys, Victoria, B.C.; 1913-14, in charge land survey party for Prov. Govt., also land ties, for G.T.P. Rly.; 1914-16, private practice, engrg. and surveying, Vancouver, B.C.; 1916, enlisted for overseas service, rejected, and in 1917, transferred to Can. Artillery, Lieut., Hdqrs. Staff, Ottawa; 1917-19, inspecting and testing engr. for artillery and engrs' stores purchased in Canada and U.S.A.; 1919 to date, in private practice, and at present, Engineer-Secretary, Vancouver Town Planning Commission, Vancouver, B.C. (*St. 1900, Jr. 1911, A.M. 1917.*)

References: C. Brakenridge, E. A. Cleveland, A. S. Gentles, W. G. Swan, E. A. Wheatley, A. C. R. Yuill.

WILSON—JOHN ARMITSTEAD, of Ottawa, Ont., Born at Broughty Ferry, Scotland, Nov. 2nd, 1879; Educ., 1900-01, St. Andrews Univ.; 1896-1900, ap'ticeship, Jas. Carmichael & Sons Ltd.; 1901-02, works and drawing office, Fairbairn Macphersons Ltd., Leeds, England; 1903 (Jan.-June), asst. engr., Union Mills, Messrs. Bird & Co., Calcutta, India; 1903-05, with same company, engr. in charge of all bldgs., plant, macby., etc., at Standard Mills, Tittaghur, and extension to same; 1905-07, asst. engr., Canada Cement Co., Exshaw, Alta.; 1907-08, asst. engr., International Portland Cement Co., Ottawa; 1908-09, partnership with A. N. Latham, engrs. and machinists; 1910-20, director of stores and contracts, Dept of Naval Service, Ottawa; 1920-22, secretary, Air Board, Ottawa; 1923-27, secretary and asst. director, R.C.A.F., Ottawa; 1927 to date, controller of civil aviation, Dept. of National Defence, Ottawa. (*A.M. 1910.*)

References: C. A. Magrath, C. Camsell, F. H. Peters, C. P Edwards, J. L. Busfield.

FOR TRANSFER FROM THE CLASS OF JUNIOR

MIDGLEY—GEORGE HENRY, of Montreal, Que., Born at Glasgow, Scotland, Oct. 19th, 1901; Educ., B.Sc. (Mech.), N S. Tech. Coll., 1924; 1918-22 (summers), mine and land survey works, wharf constrn., dfting., etc.; 1923-24 (summers), mach. shop; 1924-26, dfting, field work, etc., on mill constrn., Riordon Pulp Corpn., and International Paper Co. (Canadian); With Dodge Manufacturing Co. as follows: 1926-34, sales engr., Toronto and Montreal offices, looking after engrg., estimating, sales and erection works in Prov. of Quebec and the Maritime Provinces; May 1934 to date, sales manager, Divn of United Steel Corpn. Ltd., in charge of all Montreal office works, including engrg., sales and office management (Prov. of Quebec, Maritimes and Nfld.). (*Jr. 1928.*)

References: K. H. Marsh, W. S. Wilson, E. A. Ryan, F. O. White, W. S. Kidd, A. N. Ball, J. H. M. Jones, R. Ford, L. S. Dixon.

SINCLAIR—ARCHIBALD BEAIRSTO, of Kenogami, Que., Born at Truro. N.S., Apr. 3rd, 1902; Educ., B.Sc. (E.E.), Univ. of Man., 1927. Grad., National Radio Institute; 1922-23, field engr., Manitoba Power Co., Grand Falls; Summers: 1924-25-26, electrn., material checker and dftsman.; 1927-28, student, Canadian Westinghouse Co., Hamilton, Ont.; 1928-31, asst. to gen. elec'l. supt., Price Bros. & Co. Ltd., and 1931 to date, chief operator, Kenogami substation, for same company. (*St. 1927, Jr. 1928.*)

References: G. F. Layne, F. L. Lawton, J. F. Plow, J. N. Finlayson, J. Shanly.

FOR TRANSFER FROM THE CLASS OF STUDENT

BROWNIE—FRANK AUSTIN, of Edmonton, Alta., Born at Montreal, Que., Apr. 16th, 1908; Educ., B.Sc. (Civil), Univ. of Alta., 1934; Summer work; 1928-29-30, chainman, rodman, instr'man., C.P.R. townsite surveys; 1931, rodman, constrn. of Glenmore water supply, Calgary; 1934, instr'man on Seismic Survey, for Dominion Gas Service Ltd., Calgary; Nov. 1934 to date, with assessment branch, dept. of municipal affairs, Edmonton, at present as inspector of assessment. (*St. 1932.*)

References: R. S. L. Wilson, F. K. Beach, M. L. Gale, H. R. Webb.

CRAIN—HAROLD FOWLER, of Ottawa, Ont., Born at Ottawa, Feb. 28th, 1908; Educ., B.Sc., Queen's Univ., 1932; 1927-31 (summers), pressman, Crain Printers, Ltd.; 1931, dftsman, E. B. Eddy Co. Ltd.; 1932 to date, with Crain Printers Ltd., estimating, lithographing dept., and from Feb. 1933, vice-president in charge of production. (*St. 1932.*)

References: W. S. Kidd, C. M. Pitts, L. T. Rutledge, G. Stephenson, L. M. Arkley.

CRAWFORD—JAMES MERRILL, of 3427 Harvard Ave., Montreal, Que., Born at Howick, Que., May 3rd, 1907; Educ., B.Sc., 1929, M.Eng., 1932, McGill Univ.; 1928-29 (summers), elect'l. installn.; 1929-30, demonstrator in electr'l. engrg., McGill University; 1930 to date, elect'l. engr., Shawinigan Water and Power Co., Montreal, Que. (*St. 1928.*)

References: C. V. Christie, G. R. Hale, S. C. Hill, C. R. Reid, B. C. Hicks.

DONNELLY—WILLIAM DAVID, of Asbestos, Que., Born at Deseronto, Ont., Sept. 15th, 1904; Educ., B.Sc., Queen's Univ., 1925; 1925-26, stock layout man, 1926-30, plant engr. dftsman and surveyor, Hudson Motor Car Co., Detroit, Mich.; 1930-32, dftsman. and estimator, schedule dept., Canadian Locomotive Co. Ltd., Kingston, Ont.; 1934 to date, asst. foreman, and at present foreman, friction materials dept., Canadian Johns-Manville Co., Asbestos, Que. (*St. 1924.*)

References: L. M. Arkley, D. M. Jemmett, L. T. Rutledge, C. G. R Armstrong, W. A. Dawson.

GAUER—EDWARD, of 275 Evanson St., Winnipeg, Man., Born at Winnipeg, Apr. 29th, 1904; Educ., B.Sc. (C.E.), Univ. of Man., 1926; D.L.S., 1930, M.L.S., 1931; 1928-32, highway location and surveys, Good Roads Board, Winnipeg, Man.; 1932 to date, private and govt. surveys, at present in private practice as land surveyor and municipal engineer. (*St. 1924.*)

References: G. H. Herriot, S. E. McColl, J. N. Finlayson, A. E. MacDonald.

JACOBSEN—ERIC RIVERS, of Montreal, Que., Born at Calgoorlie, Australia, Sept. 18th, 1906; Educ., B.Sc. (C.E.), 1929, M.Eng., 1932, McGill Univ.; 1924-25, shipping clerk and asst. to acct., Maple Leaf Asbestos Mine; Three summers, one as instr'man., two as field party chief, McClare & McClare, Borough Engrs., State of New Jersey; 1929 to date, designer, Dominion Bridge Co. Ltd., Montreal, Que. (*St. 1928.*)

References: D. C. Tennant, F. P. Shearwood, E. Brown, H. R. Montgomery, A. T. Bone, R. E. Jamieson.

STOREY—THOMAS EDWARDS, of Pointe du Bois, Man., Born at Brockville, Ont., Feb. 17th, 1906; Educ., B.Sc., (E.E.), Univ. of Man., 1928; 1927 (summer), instr'man., survey party, City of Winnipeg Hydro; 1928-29, test course and engrg. office, Can. Gen. Elec. Co. Ltd.; With the City of Winnipeg Hydro-Electric System as follows: 1929-31, elect'l. layouts, including equipment lighting and control wiring; 1931-35, senior operator, Slave Falls; Feb. 1935 to date, chief operator at Slave Falls in charge of operation and mtce. (*St. 1926.*)

References: J. W. Sanger, R. H. Andrews, H. L. Briggs, C. T. Barnes, E. P. Fetherstonhaugh, A. E. MacDonald, N. M. Hall, W. M. Cruthers.

VINCENT—PAUL, of 837 Hartland Ave., Outremont, Que., Born at Montreal, Dec. 8th, 1906; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1934; 1927 (summer), quantity and report clerk, Wayagamack Pulp and Paper Co.; asst. supervisor in bldg. constrn., and summers 1930-31, asst. constrn engr., Heroux & Robert Ltd., Montreal; 1935 (June-Aug.), asst. constrn. engr., Aluminum Co. of Canada, Arvida; Aug. 1935 to date, junior engr., Water Levels Investigation Board, Dept. of Marine, Ottawa, Ont. (*St. 1934.*)

References: A. Frigon, J. A. Lalonde, J. G. Hall, A. Mailhiot, A. I. Cunningham, C. G. Cline.

WATSON—HOWARD DALTON, of Winnipeg, Man., Born at Vancouver, B.C., Sept. 8th, 1907; Educ., B.A.Sc., Univ. of B.C., 1931; 1925-30 (summers), operating engr., marine, gasoline and diesel engines; 1931-35, mtce., erection, design of and estimates on refrigerating equipment, and at present branch manager, Linde Canadian Refrigeration Co. Ltd., Winnipeg, Man. (*St. 1931.*)

References: W. H. Powell, W. R. Duckworth, T. Kipp.

WHEATLEY—ERIC EDMUND, of 657 Belmont Ave., Westmount, Que., Born at Montreal, Sept. 2nd, 1907; Educ., B.Sc., McGill Univ., 1930; Summers: 1927, dftsman., Northern Electric Co. Ltd., 1928-29, mech. and structl. dfting., Dom. Bridge Co. Ltd.; 1930-32, mech. dfting and designing, Dom. Bridge Co. Ltd.; 1932-35, demonstrator, mech. engrg. dept., McGill Univ.; April 1935 to date, sales engr., Jenkins Bros. Ltd., Montreal. (*St. 1930.*)

References: C. M. McKergow, A. Peden, C. K. McLeod, A. R. Roberts, L. R. McCurdy.

WHITSON—DUNCAN DAVID, of 617 Huron St., Toronto, Ont., Born at Toronto, Feb. 2nd, 1903; Educ., B.A.Sc., Univ. of Toronto, 1926; Summers: 1919-20, rodman, chainman, Toronto Harbour Commn.; 1921, Dept. of Northern Development; 1923, struct'l. dftsman., McGregor & McIntyre Ltd.; 1924, dftsman., Bell Telephone Co.; 1926-27, dfting room demonstrator, Univ. of Toronto; 1927-28, struct'l dfting and designing, Harkness, Loudon & Hertzberg, Toronto; 1928 to date, struct'l. engr., dept. of bldgs., City of Toronto. Checking designs of all classes of wood, steel and concrete bldgs., tanks, bins, etc. Also in charge of struct'l. design of misc. bldgs. for the city during 1932 and 1933. (*St. 1926.*)

References: A. H. Harkness, C. S. L. Hertzberg, L. A. C. Lee, A. U. Sanderson, J. R. Cockburn, J. W. Falkner, G. L. Wallace, W. S. Wilson.

EMPLOYMENT SERVICE BUREAU

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Duties.—Under direction, to make computations in connection with engineering work, and to perform other related work as required. Under direction to make detailed calculations in connection with determining the airworthiness of aircraft; to assist in making mechanical tests to determine the strength of aircraft components; under direction to examine drawings of aircraft and aircraft engines to see that they comply with the requirements for airworthiness.

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Candidates must be British subjects, and have resided in Canada for at least five years.

Situations Wanted

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

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ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

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Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

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MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

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ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

Situations Wanted

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

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CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.Sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.Sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

South African Empire Exhibition

During the period from September to December 1936, a South African Exhibition, which will include displays from all parts of the Empire, will be held in Johannesburg, and in view of the anticipated number of visitors from overseas scientific, engineering and technical institutes, the Associated Scientific and Technical Societies of South Africa have agreed to arrange that the headquarters of the Societies, i.e., Kelvin House, Fox Street, Johannesburg, together with the organization of the Associated Societies, will be placed at the disposal of duly accredited visitors.

In general, it is proposed that all visitors from overseas institutes and societies could regard Kelvin House as their headquarters during their stay in Johannesburg, and avail themselves of the facilities provided by that organization to ensure that, in addition to visiting the Empire Exhibition, they would be able to meet members of the local Institutes, and be assured that they will be welcomed by their corresponding professional colleagues in the Union and be able to obtain all information and facilities during their visit.

All information regarding travelling and the facilities to be provided in Johannesburg are obtainable from the London Secretary of the South African Empire Exhibition at 21, Tothill Street, Westminster, London, S.W., or direct from the Head Office, P.O. Box 114, Johannesburg, Transvaal.

Special travel facilities will be afforded to exhibition visitors from overseas, of which the offices named above will be able to supply particulars in due course.

"Silver Jubilee" Train

The "Silver Jubilee" train of the London and North Eastern Railway was put into service as arranged recently. On the up journey running proved to be well inside the schedule, the train arriving at King's Cross three minutes ahead of time. On the down journey in the afternoon, the times were not quite so good, arrival at destination being two minutes late. The maximum speeds are said to have been 90 m.p.h. and 91 m.p.h. for the respective journeys. Prior to the first run on regular schedule, the train was given a special trial on Friday last, when a large number of special guests were on board. This only extended as far as Grantham, but this distance was, of course, ample for the purpose of showing what could be done. The whole run to Grantham (105 m. 37 ch.) was covered in 88 min. 15 sec. The highest speed attained was 112 m.p.h. at Sandy. A speed of 100 m.p.h. was first reached 30 miles out of London and for 25 miles subsequently over 100 m.p.h. was recorded. The distance over which a speed of more than 100 m.p.h. was averaged worked out at 43 miles, 25 miles averaging 107.5 m.p.h. From Wood Green to Fletton (at which the slack for Peterborough commences) the speed worked out at 91.8 m.p.h., and on the continuous up grade of 1 in 200 for 8 miles from Wood Green to Potters' Bar, the train accelerated from 70 m.p.h. to 75 m.p.h. So far as is known, the performances at over 100 m.p.h. constitute record runs, and Mr. Gresley and the railway company are to be heartily congratulated on the performance, more especially as it is understood there was still something substantial in hand, to meet vicissitudes of weather, etc.

—*Engineering.*

LIST OF MEMBERS

OF

THE ENGINEERING INSTITUTE OF CANADA

CORRECTED TO OCTOBER 15TH, 1935

(Names of members temporarily on the Non-Active List have not been included)

In the following list (†) prefixed to a name indicates the contributor of a paper published in the Transactions of The Institute; (*G*) prefixed to a name indicates the award of the Gzowski medal; (𝔎) prefixed to a name indicates the award of the Sir John Kennedy medal; (*L*) prefixed to a name indicates the award of the Leonard medal; (*P*) prefixed to a name indicates the award of the Plummer medal; (𝔓) prefixed to a name indicates the award of the Past-Presidents' prize; (*q*) prefixed to a name indicates admission under the special provisions of the Quebec Act; (♂) prefixed to a name indicates Service with Allied Armies.

HONORARY MEMBERS

HIS ROYAL HIGHNESS EDWARD, Prince of Wales, K.G. (*Hon.M. 1919*)

H.R.H. ARTHUR, Duke of Connaught, K.G., P.C., G.B.E. (*Hon.M. 1912*)

ADAMS, Frank D., Ph.D., D.Sc., F.G.S.A., F.R.S., 1173 Mountain St., Montreal, Que. (*Hon.M. 1922*)

BESSBOROUGH, The Right Hon. the Earl of, P.C., G.C.M.G., Stansted Park, Rowlands Castle, Sussex, England. (*Hon.M. 1931*)

CLARK, Arthur L., B.Sc., Ph.D., Dean of the Faculty of Applied Science, Queen's University, Kingston, Ont. (*Affil. 1920*) (*Hon.M. 1922*)

DEVONSHIRE, His Grace the Duke of, K.G., G.C.M.G., Chatsworth House, Derbyshire, England. (*Hon.M. 1917*)

WILLINGDON, His Excellency The Right Hon. the Earl of, P.C., G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., Viceroy and Governor-General of India, Viceregal Lodge, Delhi, India. (*Hon.M. 1927*)

MEMBERS

ABBOTT, A. C., B.Sc., (McGill '26), Shawinigan Water & Power Co., Three Rivers, Que. (*H*) 677 St. Ursule St. (*S. 1925*) (*A.M. 1931*)

ABBOTT, Harold F., B.Sc., (McGill '28), Beauharnois Construction Co., Box 50, Beauharnois, Que. (*H*) Prince George, B.C. (*S. 1926*)

ABBOTT-SMITH, H. B., B.Sc., (McGill '23), Asst. Meter Engr., Shawinigan Water & Power Co., Power Bldg., Montreal, Que. (*H*) 3475 University St. (*S. 1923*) (*Jr. 1931*)

♂ABBOTT, Wm. Hamilton, Capt., M.C., address unknown. (*A.M. 1920*)

ABELL, Harry C., B.Sc. in E.E., 701 St. Louis St., New Orleans, La., U.S.A. (*M. 1904*)

ABERNETHY, Emerson, B.A.Sc., (B.C. '30), 3589 Osler Ave., Vancouver, B.C. (*S. 1927*)

ABRAMSON, Isaac Albert, B.Sc., (Alta., '29), Calgary Power Co., Seebe, Alta. (*H*) 407–15th Ave. E. (*Jr. 1931*)

ACENA, J. G., B.Sc., (McGill '30), M.Sc., (M.I.T. '31), 3433 Peel St., Montreal, Que. (*S. 1928*)

ACHESON, H. R. M., B.Sc., (Alta. '29), 10230–124th St., Edmonton, Alta. (*S. 1926*) (*Jr. 1934*)

G.†ACKERMAN, Paul, Cons. Elec. Engr., Shawinigan Water & Power Co., Power Bldg., Montreal, Que. (*H*) 4078 Hingston Ave., Montreal, Que. (*A.M. 1921*)

ACRES, Henry G., M.E. and E.E., (Tor. '03), D.Sc., Cons. Engr., H. G. Acres & Co., Niagara Falls, Ont. (*H*) 42 Culp St. (*M. 1915*)

♂ADAM, James, Capt., Specif. Engr., Chief Architect's Office, D.P.W., Canada, Hunter Bldg., Ottawa, Ont. (*H*) 263 MacLaren St. (*A.M. 1911*)

ADAM, Jos. A., Asst. Engr., D.P.W., Canada, 1254 Bishop St., Montreal, Que. (*H*) 4048 Old Orchard Ave. (*Jr. 1915*) (*A.M. 1926*)

𝔓.ADAMS, Eric G., B.Sc., (McGill '29), M.B.A., (Harvard), Econonust, C.P.R., 803 Windsor Station, Montreal, Que. (*H*) Apt. 30, 4870 Cote des Neiges Rd. (*S. 1928*) (*Jr. 1934*)

♂ADAMS, Frank P., Major, City Engineer, Brantford, Ont. (*A.M. 1910*)

ADAMS, G. R., B.Sc., (Queen's '27), Veraguas Mines Ltd., c/o Colon Import and Export Co., Colon, Panama. (*S. 1925*) (*A.M. 1934*)

ADAMS, Philip Ernest, B.Sc., (Vermont '09), Designing Engr., Canadian Bridge Co., Ltd., Walkerville, Ont. (*H*) 276 Victoria Rd. (*M. 1927*)

♂ADAMS, Wm. Douglas, Major, M.C., (R.M.C., Kingston '08), Toronto Mgr., H. E. McKeen & Co., Ltd., 442 Wilson Bldg., Toronto, Ont. (*H*) 63 Blythewood Rd. (*S. 1908*) (*Jr. 1912*) (*A.M. 1922*)

ADDIE, Donald Kyle, B.Sc., (McGill '25), Mech. Engr., Dominion Glass Co., Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*Jr. 1926*)

ADDIE, Geo. Kyle, Lt.-Col., B.A.Sc., (McGill '89), Q.L.S., Private Practice, 23 St. Louis St., Quebec, Que. (*H*) 148 St. Cyrille St. (*S. 1887*) (*A.M. 1898*) (*M. 1935*)

ADDISON, John H., B.A.Sc., (Tor. '33), Res. Engr., C. A. Billings, Cons. Mining Engr., 294 St. Clair Ave. E., Toronto, Ont. (*H*) 431 Broadview Ave. (*S. 1932*) (*Jr. 1935*)

♂ADLARD, L. S., Major, B.A.Sc., (Tor. '15), Executive Engr., P.W.D., Dharmsala, Kangra Dist., Punjab, India. (*H*) 61 Howard St., Toronto, Canada. (*S. 1914*) (*A.M. 1924*)

ADLINGTON, Wilfred Ernest, B.Sc., (M.I.T. '27), Mgr. of Sales and Prod., Bennett (Hyde) Ltd., Boston Mills, Hyde, Cheshire, England. (*H*) Windy Ridge, Weineth Low, Gee Cross, Cheshire. (*Jr. 1928*)

AEBERLI, J. Adolf, M.E., Mech. Engr., Hydro-Electric Power Comm. of Ontario, Toronto, Ont. (*H*) 257 Kingswood Rd. (*M. 1921*)

AFFLECK, Garnet, Dist. Engr., D.P.W., Man., Rm. 316, Parliament Bldgs., Winnipeg, Man. (*H*) 674 Fisher St. (*S. 1909*) (*Jr. 1912*) (*A.M. 1920*)

AFFLECK, John K., B.A.Sc., (Tor. '21), Supt., Dry Colour Dept., Imperial Varnish and Colour Co. Ltd., 6 Morse St., Toronto, Ont. (*H*) 26 Cavendish St. (*S. 1920*) (*A.M. 1922*)

AGAR, George, Chief Designer and Estimator, Indust. Dept., Canadian Vickers, Ltd., P.O. Box 550, Montreal, Que. (*H*) 64 Nelson St., Montreal West, Que. (*A.M. 1924*)

AGGIMAN, Jacques Nissim, B.Sc., (McGill '17), Contractor, Box 249, Angora, Turkey. (*S. 1916*) (*Jr. 1917*) (*A.M. 1919*) (*M. 1929*)

AGNEW, T. Chas., B.Sc., (Queen's '29), Minneapolis-Honeywell Co. Ltd., Toronto, Ont. (*H*) 350 Concord Ave. (*S. 1928*)

AHEARN, Wm. J., 538 MacLaren St., Ottawa, Ont. (*S. 1935*)

AHERN, Arthur Weston, B.Sc., (McGill '22), Vice-Pres., The James Ruddick Engineering Construction Co., Quebec, Que. (*H*) 255 Fraser St. (*S. 1920*) (*A.M. 1926*)

AITKENS, John C., B.Sc., (Man. '33), Office Engr., Water Development Committee, Swift Current, Sask. (*H*) Boissevain, Man. (*S. 1928*) (*Jr. 1934*)

AKIN, T. Bernard, B.Sc., (N.S.T.C. '32), Clifton Ave., Windsor, N.S. (*S. 1932*)

♂ALBERGA, Albert Miller, B.Sc., (McGill '16), 40 Market St., Montego Bay, Jamaica, B.W.I. (*S. 1915*) (*Jr. 1920*) (*A.M. 1925*)

ALDER, J. Dacre, Asst. Chief Engr., Darling Bros., Ltd., P.O. Box 940, 140 Prince St., Montreal, Que. (*M. 1921*)

ALDRED, John James, c/o G. R. Gray, Esq., R.R. 1, Waterloo, Que. (*A.M. 1907*)

ALEXANDER, Alwin Paul, B.Sc., (Alta '33), Monarch, Alta. (*S. 1933*)

ALEXANDER, David Tasker, Chief Dftsman, The Canadian Bridge Co. Ltd., Walkerville, Ont. (*H*) 106 Indian Rd., Sandwich, Ont. (*M. 1931*)

ALEXANDER, Fred. Wm., Engr., Mtce. of Way, Western Lines, C.P.R., Winnipeg, Man. (*A.M. 1907*) (*M. 1917*)

ALEXANDER, Richard C. F., (R.M.C., Kingston '96), Sr. Office Engr., Dept. Rlys. and Canals, Ottawa, Ont. (*H*) 370 Lewis St. (*S. 1897*) (*A.M. 1904*)

♂ALEXANDER, Stanley Geo., Steam Power Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 460 Sherbrooke St. (*Affil. 1935*)

ALISON, J. Gardner Robb, (Tor. '03), Res. Engr., Dept. of Northern Development, Pays Plat, Ont. (*H*) 26 Glen Ayr Rd., Forest Hill Village, Ont. (*A.M. 1920*)

†ALLAIRE, Alexander, M.E., Acting State Director, P.W.A., Little Rock, Ark., U.S.A. (*A.M. 1910*) (*M. 1913*)

♂ALLAN, E. Blake, Capt., M.C., B.A.Sc., (Tor. '16), C.E., Res. Engr., Prov. Highway Dept., P.O. Box 293, Woodstock, N.B. (*S. 1915*) (*A.M. 1920*)

♂ALLAN, J. Lorn, Capt., B.A.Sc., (Tor.), Town Engr., 32 Newcastle St., Dartmouth, N.S. (*S. 1899*) (*A.M. 1904*) (*M. 1913*)

†ALLCUT, Edgar Alfred, B.Sc., M.Sc., (Birmingham '09), Prof. Mech. Engrg., University of Toronto, Toronto, Ont. (*H*) 48 Foxbar Rd. (*M. 1926*)

ALLEN, Charles Albert, Str'l. Designer, Archt.'s Office, Bell Telephone Co. of Canada, Montreal, Que. (*H*) 44 Lake Ave., Strathmore, Que. (*A.M. 1921*)

ALLEN, Norman, B.A.Sc., (Tor. '27), Box 37, Ingersoll, Ont. (*Jr. 1929*)

ALLEN, Richard T. W., B.Sc., (Alta. '35), P.O. Box 891, Vernon, B.C. (*S. 1935*)

ALLEN, Robt. William, Asst. City Engr., Regina, Sask. (*H*) 2360 Smith St. (*Jr. 1918*) (*A.M. 1922*)

ALLINGHAM, Ralph, Supt. of Constrn., Semet Solvay Engineering Corpn., 40 Rector St., New York, N.Y. (*H*) 234 Martine Ave., White Plains, N.Y. (*S. 1914*) (*Jr. 1919*) (*A.M. 1923*)

ALLISON, Jesse Graham, B.Sc., (S. Calif. '27), Commercial Tires Ltd., 638 Dorchester St. W., Montreal, Que. (*S. 1924*) (*Jr. 1931*)

ALLISON, John Logie, Box 313, Ottawa, Ont. (*A.M. 1887*) (*M. 1895*) (*Life Member*)

AMAN, T. F. S., B.Sc., (Queen's '35), 77 Highland Ave., Belleville, Ont. (*S. 1934*)

AMBROSE, John R. W., E.M., Supt., Toronto Terminals Railway Co., 402 New Union Station, Toronto, Ont. (*H*) 109 Dowling Ave. (*A.M. 1911*) (*M. 1913*)

AMES, Arthur John, Mang'g. Director, Instruments, Ltd., 240 Sparks St., Ottawa, Ont. (*H*) 184 Holmwood Ave. (*Affil. 1922*)

AMOS, Arthur (*q*), (Ecole Polytech., Montreal), Director, Hydraulic Service, Dept. of Lands and Forests, Parliament Bldgs., Quebec, Que. (*H*) 31 Mt. Carmel St. (*A.M. 1899*)

AMOS, Louis Auguste, (R.M.C., Kingston), Arch. and C.E., L. A. & P. C. Amos, 1414 Crescent St., Montreal, Que. (*H*) 592 St. Joseph St. S., Lachine, Que. (*S. 1893*) (*A.M. 1896*) (*M. 1915*)

ANDERSEN, Viggo, B.Sc., (R.T.C., Copenhagen), 758 Victoria Ave., St. Lambert, Que. (*Jr. 1928*)

♂ANDERSON, Chas., Capt. R.E., Carnoustie, Scotland. (*A.M. 1928*)

ANDERSON, Clarence Aubrey, 546 Oakland Rd., Halifax, N.S. (*A.M. 1932*)

ANDERSON, Dan., B.Sc., (McGill '23), Elec. Engr., Power Corp. of Canada, Montreal, Que. (*H*) 35 Beverley Ave., Town of Mt. Royal, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1930*)

ANDERSON, Frederick, Capt., (R.M.C., Kingston), Hydrographer and Director, Hydrographic Services, Dept. of Marine, Canada, Hunter Bldg., Ottawa, Ont. (*H*) 150 Metcalfe St. (*M. 1909*)

ANDERSON, G. S., B.Sc., (Sask. '31), Theodore, Sask. (*S. 1931*)

ANDERSON, John Marshall, Res. Engr., Main Highways Br., D.P.W., Alta., Edmonton, Alta. (*A.M. 1919*)

♂ANDERSON, John N., Lieut., (R.T.C., Glasgow), Man'g. Director, Wm. N. O'Neil Co. (Victoria), Ltd., 551 Yates St., Victoria, B.C. (*H*) 2000 Beach Drive. (*A.M. 1919*)

ANDERSON, Roderick Victor, B.A.Sc., (B.C. '31), Inter. Petroleum Co., Talara, Peru, S.A. (*S. 1928*)

♂ANDERSON, T. V., Brig., D.S.O., B.Sc., (McGill), Quartermaster-Gen., Dept. National Defence, Ottawa, Ont. (*H*) 459 Laurier Ave. E. (*S. 1900*) (*A.M. 1911*)

ANDERSON, William, 2640 Alder St., Vancouver, B.C. (*M. 1913*) (*Life Member*)

ANDERSON, Wm., Mgr., Calgary Water Power Co. Ltd., Calgary, Alta. (*H*) 2713 Montcalm Crescent. (*A.M. 1924*)

ANDREWES, Wm. E., B.Sc., (McGill '27), Capt. R.C.E., H.Q., M.D. No. 2, 185 Spadina Ave., Toronto, Ont. (*H*) 69 Standish Ave. (*Jr. 1930*)

ANDREWS, Russell Herbert, B.Sc., (Man. '24), Elec. Engr., City of Winnipeg Hydro-Electric System, Winnipeg, Man. (*H*) 398 Maryland St. (*A.M. 1929*)

ANGEL, Frederick Wm., M.B.E., B.A.Sc., (McGill '98), Man'g. Dir., United Nail and Foundry Co., 132 Hamilton St., St. John's, Nfld. (*A.M. 1905*)

ANGEL, John B., B.Eng., (McGill '35), 146 Hamilton St., St. John's, Nfld (*S. 1935*)

ANGELL, Henry Gerald, Chief Engr., Eastern Irrigation Dist., Brooks Alta (*Jr. 1914*) (*A.M. 1922*)

♂ANGLIN, Douglas Gould, Major, B.Sc., C.E., (Queen's '12), Asst. Mgr., Anglin-Norcross, Ltd., 892 Sherbrooke St. W., Montreal, Que. (*H*) 5 St. George's Place, Westmount, Que. (*S. 1912*) (*A.M. 1920*)

ANGLIN, Arthur Baker, B.Sc., (Queen's '33), Asst. Chief Chemist, The British American Oil Refineries Ltd., Royal Bank Bldg., Toronto, Ont. (*H*) Apt. 302, 1524 Bathurst St. (*S. 1933*)

ANGUS, F. William, B.Sc., (McGill '29), Trans. Engr., Bell Telephone Co. of Canada, Montreal, Que. (*H*) 3065 Cedar Ave. (*S. 1929*) (*A.M. 1931*)

♂ANGUS, John Vickers, Montreal Engineering Co., 244 St. James St., Montreal, Que. (*A.M. 1922*)

ANGUS, Robert W., B.A.Sc., (Tor. '97), Prof., Head of Dept. of Mech. Engrg., University of Toronto, Toronto, Ont. (*M. 1921*)

ANGUS, William Forrest, Vice-Pres., Can. Car and Foundry Co., Ltd., 621 Craig St. W., Montreal, Que. (*H*) 3564 Peel St. (*S. 1895*) (*A.M. 1903*) (*M. 1913*)

ANNETT, Fred A., Assoc. Editor, "Power," McGraw-Hill Publishing Co. Inc., 330-W. 42nd St., New York, N.Y. (*H*) 143-72 Cherry Ave., Flushing, N.Y. (*Affil. 1927*)

ANSON, Clement Matthew, B Sc., (McGill '25), Asst. Gen. Mgr., Dom. Steel and Coal Corp., Ltd., Sydney, N.S. (*H*) 46 Rigby Rd. (*A.M. 1931*)

ANTENBRING, Clarence V., B.Sc., (Man. '26), Designer, Cowin & Co., Pacific and Yeoman Sts., Winnipeg, Man. (*H*) 417 Machray Ave. (*S. 1924*)

ANTHONY, Frank D., "Grove Place," West Chicago, Ill. (*M. 1902*) (*Life Member*)

ANTLIFF, Jas. C., B.Sc., (McGill '23), Gen. Asst., Montreal Light, Heat and Power Cons., P.O. Box 1710, Montreal, Que. (*H*) 3791 Marlowe Ave., N.D.G. (*S. 1923*) (*A.M. 1928*)

ANTONISEN, Joachim, Civil Engr., 431 St. Patricks Sq., Port Arthur, Ont. (*A.M. 1907*) (*M. 1921*)

ARCAND, Charles L., Asst. Engr., D.P.W., Canada, Three Rivers, Que. (*H*) 575 Volontaire St. (*A.M. 1919*)

ARCAND, Louis J., B.Sc., (McGill '31), (M.Eng., '32), 7074 De Normanville St., Montreal, Que. (*S. 1929*)

ARCHAMBAULT, Jos. U., B.Sc., (Ecole Polytech., Montreal, '27), Engr., Quebec Public Service Comm., Court House, Quebec, Que. (*H*) 54 St. Ursule St. (*S. 1925*) (*A.M. 1931*)

ARCHER, Maurice Geo., (R.M.C., Kingston), Langlois & Dufresne, Cons. Engrs., 105 Mountain Hill, Quebec, Que. (*H*) 330 Grande Allee. (*S. 1933*)

ARCHIBALD, Charles Blair, Mgr., Wabana Opers., Dominion Steel and Coal Co., Ltd., Wabana, Nfld. (*S. 1910*) (*A.M. 1917*)

†ARCHIBALD, Ernest M., B.Sc., (McGill '99), Vice-Pres., E. F. Powers Construction Co., Ltd., 318 Harvey Bldg., West Palm Beach, Fla. (*A.M. 1906*)

ARCHIBALD, Harry P., B.A.Sc., Sole Partner, Bayfield & Archibald, 448 Seymour St., Vancouver, B.C. (*H*) 1304 Walnut St. (*A.M. 1910*)

ARCHIBALD, Manning C., B.Sc., (N.S.T.C. '33), 201 Prince St., Charlottetown, P.E.I. (*S. 1931*)

♂ARCHIBALD, Samuel Wallace, Major, B.A.Sc., (Tor. '22), O.L.S. '25, Cons. Engr. and L.S., Victor Bldg., 284 Dundas St., London, Ont. (*H*) 292 Queens Ave. (*A.M. 1928*) (*M. 1935*)

ARKLEY, Lorne McK., C.E., M.Sc., (McGill '00), Prof. Mech. Engrg., Queen's University, Kingston, Ont. (*H*) 22 Kensington Ave. (*S. 1899*) (*A.M. 1906*) (*M. 1914*)

ARMSTRONG, Arnold V., B.Sc., (McGill '23), i/c Illumination Sales, Northern Electric Co. Ltd., 131 Simcoe St., Toronto, Ont. (*H*) 141 Deloraine Ave. (*S. 1920*) (*Jr. 1929*)

ARMSTRONG, C. G. Pussell, B.A.Sc., (Tor. '20), O.L.S., Partner, Newman & Armstrong, Cons. Engrs. and Surveyors, 301-2 Davis Bldg., Windsor, Ont. (*H*) 152 Josephine Ave. (*Jr. 1921*) (*A.M. 1925*) (*Member of Council, E.I.C.*)

ARMSTRONG, Douglas Bond, Erection Engr., Dominion Bridge Co., Ltd., Montreal, Que. (*H*) 4196 Hingston Ave. (*A.M. 1923*)

ARMSTRONG, H. V., (Tor. '09), Asst. Station Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) Richmond Hill, Ont. (*A.M. 1915*)

ARMSTRONG, Henry W. D., 128 Roxborough St. W., Toronto, Ont. (*M. 1887*) (*Life Member*)

ARMSTRONG, John Edwin, C.E., (Cornell '08), Asst. Chief Engr., C.P.R., Rm. 401, Windsor Station, Montreal, Que. (*H*) 4060 Marlowe Ave. (*A.M 1917*)

ARMSTRONG, L. H., B.Sc., (McGill '22), Asst. Engr. in Trans. and Equipment Dept., Companhia Telephonica Brasileira, Caixa Postal 2835, Rio de Janeiro, Brazil. (*H*) 30 Summerhill Ave., Montreal, Que. (*S. 1919*) (*A M. 1930*)

ARMSTRONG, Owen F. C., B.Sc., (N.S.T.C. '28), Asst. to Personnel Superv., Bell Telephone Co. of Canada, Rm. 800, 1050 Beaver Hall Hill, Montreal, Que. (*S. 1926*) (*A.M. 1935*)

ARMSTRONG, Thomas S., Chief Locating Engr., Dept. of Northern Development, Parliament Bldgs., Toronto, Ont. (*M. 1907*) (*Life Member*)

ARMSTRONG, Walter J., B.Sc., (Cornell '09), Cons. Engr., Rm. 703, Dominion Square Bldg., Montreal, Que. (*H*) 15 Willow Ave. (*A.M. 1916*) (*M. 1921*)

♂ARNOLD, Guy Walker, B.Sc., (N.B. '12), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 272 Stinson Crescent. (*A.M. 1928*)

ARTHEY, Geo. Clayton, B.Sc., (Queen's '34), Nichols Chemical Co., Sulphide, Ont. (*H*) Tweed, Ont. (*S. 1934*)

†ASHBRIDGE, Wellington Thomas, C.E., (Tor. '88), 1444 Queen St E., Toronto, Ont. (*S. 1887*) (*A.M. 1892*) (*Life Member*)

†ASHCROFT, Glenn B., B.S., and C.E., (Case '00), Sr. Strl. and Constrn. Engr., California State D.P.W., Divn. Architecture, P.W. Bldg., Sacramento, Calif. Address: 1823 Alameda Ave., Alameda, Calif. (*A.M. 1904*)

♂ASHFORD, Arthur Geo., Major, Asst. Engr., Project No. 39, D.N.D., Valcartier Camp, Que. (*A.M. 1930*)

♂ASHWORTH, John Kershaw, Engr.-Mgr., R. & M. Bearings Canada, Ltd., 1006 Mountain St., Montreal, Que. (*H*) 1485 Bernard Ave., Outremont, Que. (*A.M. 1926*)

ASKIN, R. J., B.Sc., (Queen's '23), Mill Mgr., Thunder Bay Paper Co. Ltd., Box 307, Port Arthur, Ont. (*H*) 524 Red River Rd. (*S. 1922*) (*A.M. 1926*)

ASKWITH, Frank Chatham, Commr. of Works, Corp. of Ottawa, City Hall, Ottawa, Ont. (*H*) 222 Powell Ave. (*S. 1910*) (*Jr. 1913*) (*A.M. 1919*)

ASSELIN, Jean, B.A.Sc., C.E., (Ecole Polytech., Montreal '29), Municipal Mgr., La Tuque, Que. (*A.M. 1934*)

ATKINSON, Fred, Pres. and Gen. Mgr., Atwood Ltd., 520 University Tower, Montreal, Que. (*H*) 3425 Montclair Ave. (*Affil. 1925*)

ATKINSON, M. Brodie, B.Sc., (McGill '04), Asst. Supt'g. Engr., Dept. of Rlys. and Canals, Welland Ship Canal, St. Catharines, Ont. (*H*) 150 Ontario St. (*S. 1904*) (*A.M. 1909*) (*M. 1918*)

ATTENBOROUGH, Ernest A., Dept. of Works, City of Toronto, Rm. 6, City Hall, Toronto, Ont. (*H*) 72 East Lynn Ave. (*Jr. 1935*)

ATTFIELD, Arthur Evans, Surveys Engr., Dept. National Defence, Ottawa, Ont. (*H*) 171 Belmont Ave. (*A.M. 1926*)

ATTWOOD, Chas. Hartley, Deputy Minister of Mines and Natural Resources, Man., Parliament Bldgs., Winnipeg, Man. (*H*) 6 Rochester Apts., Edmonton St. (*A.M. 1915*)

ATWOOD, Arthur Gerald Lysons, B.Sc., (N.S.T.C. '27), Retail Engr. i/c Install., Iron Fireman Mfg. Co. of Canada, 1124 Beaver Hall Hill, Montreal, Que. (*S. 1927*) (*A.M. 1934*)

ATWOOD, Wm. S., Vice-Pres., Can. Car & Foundry Co. Ltd., 621 Craig St. W., Montreal, Que. (*H*) 659 Murray Hill, Westmount, Que. (*M. 1914*)

AULD, Wm. Fraser, B.A.Sc., (Tor. '27), Lincoln Electric Co. of Canada Ltd., 65-67 Bellwoods Ave., Toronto 3, Ont. (*H*) 1574 Bathurst St. (*Jr. 1929*)

♂AUSTIN, Frank Douglas, B.A.Sc. (Tor. '15), Res. Engr., Dept. of Northern Development, Ignace, Ont. (*A.M. 1934*)

AVERY, Eric, Engr., Dom. Bridge Co. Ltd., Calgary, Alta. (*H*) 733 Alexander Crescent. (*A.M. 1935*)

AYER, Thos. Haliburton, B.Sc., (N.S.T.C. '30), 16 Dominion St., Moncton, N.B. (*S. 1930*)

♂BABBITT, Archie Randolph, B.Sc., (N.B. '10), 301 University Ave., Fredericton, N.B. (*A.M. 1924*)

♂BABBITT, Sam. Wellington, Mining Engr., Minto Coal Co. Ltd., Minto, N.B. (*A.M. 1929*)

BABCOCK, Harold Austin, B.A.Sc., (Tor. '17), Partner, Margison & Babcock, 609 Maclean Bldg., Toronto, Ont. (*H*) 103 Sheldrake Blvd. (*A.M. 1922*)

BACKLER, I. S., B.Eng., (McGill '32), Cons. Engr., 360 Recollet St., Montreal, Que. (*H*) 5331 Mance St. (*S. 1930*)

BACON, Chas. I., B.Sc., (N.S.T.C. '34), North Tryon, P.E.I. (*S. 1930*)

♂BACON, Thos. H., Lieut., B.Sc., (McGill '11), Inspr., Can. Fire Underwriters' Assoc., 524 Coristine Bldg., 20 St. Nicholas St., Montreal, Que. (*H*) Apt. 4, 17 Chesterfield Ave., Westmount, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1921*)

♂BADGLEY, Leonard Amey, Lieut., B.A.Sc., (Tor. '11), Engr., City of Toronto, Dept. of Bldgs., City Hall, Toronto, Ont. (*H*) 106 Lawrence Ave. E. (*Jr. 1914*) (*A.M. 1924*)

BAGGS, Wm. Clyde, 3506 University St., Montreal, Que. (*H*) Curling, Nfld. (*S. 1935*)

BAILEY, Chas. David, Engr., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 544 Notre Dame St., Lachine, Que. (*A.M. 1935*)

♂BAILEY, Harold Milton, Capt., Town Engr., Melville, Sask. (*A.M. 1922*)

BAILEY, Loring W., B.Sc., (McGill '25), Sta. Supt., Gatineau Power Co., Grand Falls, N.B. (*S. 1922*)

BAILLIE, Edward Leonard, B.Sc., (N.S.T.C. '26), Asphalt Sales Engr., Imperial Oil Ltd., Halifax, N.S. (*H*) 348 Quinpool Rd. (*Jr. 1926*) (*A.M 1931*)

BAIN, Archie Marcus, B.Sc., (Man. '28), Str'l. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 4898 Mayfair Ave., Montreal, Que. (*S. 1925*) (*Jr. 1930*)

BAIN, Wm. Alex., B.A.Sc., (B.C. '26), Res. Engr., B.C. Pulp and Paper Co. Ltd., Woodfibre, B.C. (*A.M. 1934*)

BAINBRIDGE, Robert Arthur, 19 Marlborough Ave., Victoria, B.C. (*M. 1903*) (*Life Member*)

BAIRD, Albert Foster, B.Sc. (E.E.), (N.B. '14), M.Sc., (N.B. '17), Prof. of Elec. Engrg., University of N.B., Fredericton, N.B. (*H*) 800 Regent St. (*A.M. 1922*) (*M. 1927*)

BAIRD, Earle Meharg, B.A.Sc., (Tor. '23), Engr., Township of Scarboro, 1683 Kingston Rd., Toronto 13, Ont. (*H*) 11 Avalon Blvd. (*Jr. 1925*)

BAIRD, John A., B.A.Sc., (Tor. '11), O.L.S., Cons. Engr. and Surveyor, Royal Bank Bldg., Sarnia, Ont. (*H*) Corunna, Ont. (*M. 1926*)

BAIRD, J. Boyd, M.Sc., (McGill '09), Secy., Newfoundland Board of Fire Underwriters, Bank of N.S. Bldg., Water St., St. John's, Nfld. (*H*) 11 Monkstown Rd. (*S. 1908*) (*A.M. 1913*)

BAKER, C. M., B.Sc., (Queen's '33), Hastings, Ont. (*S. 1928*)

♂BAKER, Jas. Davidson, Lieut., Deputy Minister and Gen. Mgr., Alberta Govt. Telephones, C.P.R. Bldg., Edmonton, Alta. (*H*) 11045-85th Ave. (*M. 1935*)

BAKER, John Arthur, B.A.Sc., (B.C. '30), 2332 Clifton Ave., N.D.G., Montreal, Que. (*H*) R.R. Eburne, B.C. (*S. 1930*)

BAKER, Stephen Malor, B.Sc., (McGill '29), Asst. Plant Engr., Proctor & Gamble, Ltd., Hamilton, Ont. (*H*) 12 Mareve Ave. (*S. 1927*)

BAKHMETEFF, His Excellency, Prof. Boris A., Cons. Engr., Rm. 1425, 250 West 57th St., New York, N.Y., Prof., Columbia University. (*H*) 55 East 72nd St. (*M. 1917*)

BALDRY, Geo. S., 810 Wolseley Ave., Winnipeg, Man. (*S. 1931*)

BALDWIN, R. A., Engr. of Constrn., C.N.R., Rm. 439, Union Station, Toronto, Ont. (*H*) 26 Oriole Gardens. (*M. 1919*)

BALDWIN, Wm. A., B.Sc., (McGill '29), Supt., High Falls Generating Station, Maclaren Quebec Power Co., Buckingham, Que. (*S. 1929*)

BALFOUR, Reginald H., B.Sc., (McGill '97), Sales Mgr., Eugene F. Phillips Electrical Works, Ltd., 5795 De Gaspe Ave., Montreal, Que. (*H*) 644 Belmont Ave., Westmount, Que. (*S. 1899*) (*A.M. 1903*)

BALL, Alf. N., B.Sc., (Queen's '14), D.L.S., S.L.S., Chief Engr., E. B. Eddy Co., Hull, Que. (*H*) 119 Powell Ave., Ottawa, Ont. (*A.M. 1919*)

BALL, Francis Caldwell, B.A.Sc., (Tor. '23), Asst. Sewer Engr., Corp. of City of London, City Engr.'s Dept., City Hall, London, Ont. (*H*) 374 Tecumseh Ave. (*S. 1920*) (*A.M. 1926*)

♂BALL, Spencer, Lieut., B.Sc., (Sask. '16), Asst. Prof. Civil Engrg., Nova Scotia Technical College, Halifax, N.S. (*H*) 196 Atlantic St. (*S. 1915*) (*Jr. 1920*) (*M. 1932*)

BALL, Walter Lance, Cape North, Victoria County, N.S. (*A.M. 1921*)

BALLANTYNE, Norman F., M.E., (Cornell '93), 110 Hawthorne Ave., Ottawa, Ont. (*A.M. 1906*)

♂BALLANTYNE, Thomas B., B.Sc., (McGill '08), 215 High Park Ave., Toronto, Ont. (*S. 1908*) (*A.M. 1913*)

BALLARD, B. G., B.Sc., (Queen's '24), Asst. Research Physicist, National Research Council, Sussex St., Ottawa, Ont. (*H*) 297 James St. (*A.M. 1931*)

BALLENY, Jas. L., B.Sc., (McGill '25), Beauharnois Light, Heat and Power Co., Power House, P.O. Box 136, Beauharnois, Que. (*S. 1922*) (*A.M. 1931*)

BALLS, Matthew, Asst. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 26 Stratford Rd., Hampstead, Que. (*A.M. 1919*)

BALTZELL, Willie Harry, Chief Engr., Canadian Steel Corp'n., Ltd., Ojibway, Ont. (*M. 1920*)

BALTZER, Clarence Edwin, B.Sc., (Queen's '20), Tech. Engr., Fuel Research Labs., Mines Br., Dept. of Mines, 560 Booth St., Ottawa, Ont. (*H*) 13 St. Francis St. (*S. 1919*) (*A.M. 1925*)

BANG, Claus M., B.Sc., Elec. Supt., Can. International Paper Co., Three Rivers, Que. (*H*) 1007 Notre Dame St. (*A.M. 1922*)

♂BANGS, Raymond Gardner, Lieut., B.Sc., (McGill '16), Transp. and Public Utilities Br., Bureau of Statistics, Dept. of Trade and Commerce, Ottawa, Ont. (*H*) 191 Somerset St. W. (*S. 1916*) (*A.M. 1919*)

BANKS, S. R., M.Eng., (Liverpool '24), Asst. Engr., Monsarrat & Pratley, 909 Drummond Bldg., Montreal, Que. (*Jr. 1930*) (*A.M. 1934*)

BARBER, James Henry, 223 Indian Road, Toronto, Ont. (*M. 1887*) (*Life Member*)

BARBER, Wm., B.A.Sc., (Tor. '06), Director, Kilmer, Gibson & Van Nostrand, Spadina and Fleet Sts., Toronto, Ont. (*H*) 106 Roncesvalles Ave. (*A.M. 1911*)

BARBOUR, C. A., B.Sc., (N.B. '31), Mgr., Maritime Radio and Electrical Supplies, 120 Germain St., Saint John, N.B. (*H*) 174 King St. E. (*S. 1930*)

BARBOUR, Frank A., B.A., Cons. Engr., 1119 Tremont Bldg., Boston, Mass. (*M. 1904*)

BARCLAY, Malcolm D., B.Sc., (McGill '07), D.L.S., Q.L.S. and C.E., M. D. Barclay & Co., Rms. 806-8, 159 Craig St. W., Montreal, Que. (*H*) 3625 Durocher St. (*S. 1907*) (*A.M. 1912*)

♂BARCLAY, Noel M., Lieut., M.C., B.Sc., (Glasgow), Asst. Engr., Montreal Sewers Comm., City Hall, Montreal, Que. (*H*) 3496 Cote des Neiges Rd. (*A.M. 1914*)

♂BARLTROP, Ivan Chas., Capt., B.A., (Cantab.), Asst. Engr., D.P.W. of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 1954 Monteith St. (*A.M. 1923*)

BARNES, Chas. T., Str'l. Engr., City of Winnipeg Hydro-Electric System, 55 Princess St., Winnipeg, Man. (*H*) 343 Dubuc St., Norwood. (*Jr. 1920*) (*A.M. 1923*)

BARNES, Chiles M., 36-01 31st Ave., Astoria, N.Y. (*Jr. 1917*) (*A.M. 1922*)

BARNES, Frank Harvey, B.Sc., (McGill '12), Port Hope, Ont. (*A.M. 1928*)

♂BARNES, Harry Fairweather, B.Sc., (N.B. '12), Secy. and Municipal Engr., British Municipal Council, Tientsin, China. (*H*) 170 Bruce Rd. (*A.M. 1916*) (*M. 1924*)

BARNES, John, Mech. Designer, Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 5 Gottesmore St., Sub. P.O. No. 1. (*A.M. 1921*)

BARNETT, Thos. Arthur, Gen. Supt., Stewart & Grant, Winnipeg, Man. (*H*) 2408 Stanley St., Niagara Falls, Ont. (*A.M. 1922*)

BARNHILL, B. E., B.Eng., (King's, Halifax '99), Chief Engr., West Slope Construction Co., P.O. Box 146, Azusa, Calif. (*A.M. 1907*) (*M. 1921*)

BARNHOUSE, Frank Wm., B.Sc., (Alta. '34), Jr. Engr., Can. Gen. Elec. Co. Ltd., Wards St. Works, Toronto, Ont. (*H*) 69 McFarland Ave. (*S. 1933*)

♂BARNS, Bird Lee, Capt., B.Sc., (Mich. '06), Alternating Current Designing Engr., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 581 Gilmour St. (*A.M. 1919*)

BARNSLEY, Frank R., B.A.Sc., (B.C. '27), Can. Gen. Elec. Co., Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 5245 Byron Ave. (*S. 1924*)

♂BARNUM, John Baylor, Field Engr., Beauharnois Light, Heat and Power Co., Beauharnois, Que. (*A.M. 1922*)

BARR, F. G. F., B.A.Sc., (Tor. '26), Gen. Traffic Dept., Bell Telephone Co. of Canada, Ltd., Toronto, Ont. (*H*) 127 Walmer Rd. (*S. 1926*)

BARR, Shirley, Chief Engr., Canada Cement Co., Ltd., Montreal, Que. (*H*) Apt. 14, 3610 Durocher St. (*M. 1921*)

BARRATT, E. F., 21 Strath Ave., Toronto, Ont. (*S. 1932*)

♂BARRETT, Andrew Grant, B.Sc., (Queen's '21), Williamstown, Ont. (*S. 1921*) (*Jr. 1925*) (*A.M. 1931*)

BARRINGTON, Yorke C., Town Engr., Town Hall, Box 629, Sydney Mines, N.S. (*A.M. 1923*)

♂BARRY, David, Major, Engrg. Branch, Dept. of National Defence, Birks Bldg., Ottawa, Ont. (*A.M. 1911*)

BARRY, William Henry, Chief Engr., Worth Bros. Inc., 4400 Worth St., Los Angeles, Calif. (*H*) 8178 N Chestnut Ave., South Gate. (*A.M. 1924*)

BARTEAUX, Ross M., B.Sc., (N.S.T.C. '24), Asst. Supt., Light and Power Dept., Nova Scotia Light and Power Co., Halifax, N.S. (*H*) 21 Cleveland Crescent, Dartmouth, N.S. (*A.M. 1931*)

BARTON, E. A., B.Sc., (Queen's '31), Dom. Engineering Co Ltd., Lachine, Que. (*S. 1928*)

♂BARTON, Harold Miall, Lieut., D.L.S. and Geodetic Engr., Dept. Interior, Ottawa, Ont. (*H*) 31 Broadway Ave. (*A.M. 1921*)

♂BARTON, Robert A., Lieut., B.Sc., Private Practice, Box 198, Penticton B.C. (*A.M. 1910*)

BARWICK, Oliver A., B.Arch., (McGill '14), Asst. Arch't., Dept. National Defence, 507 Canadian Bldg., Ottawa, Ont. (*H*) 45 Sunset Ave., Highland Park. (*A.M. 1923*)

BASTABLE, Ross W., B.Sc., (McGill '22), Superv. of Bldgs., E.A., Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 96–44th Ave., Lachine, Que. (*S. 1920*) (*A.M. 1930*)

♂BATE, Chas. Ben., Capt., M.C., D.C.M., B.Sc., (Queen's '15), Engr. i/c, Project 39, Dept. National Defence, Valcartier, Que. (*A.M. 1919*)

BATES, Charles Lynn, B.S. in C.E., (M.I.T. '03), Mtce. of Way Engr., P.G.E. Rly., Squamish, B.C. (*H*) 2243–1st Ave. W., Vancouver, B.C. (*A.M. 1907*)

BATES, Harold C., B.Sc., (Queen's '17), Dist. Engr., Bell Telephone Co. of Canada, 76 Adelaide St. W., Toronto, Ont. (*H*) 40 Baby Point Rd. (*S. 1916*) (*Jr. 1920*)

♂BATY, Edward, 2nd Lieut., Dist. Plant Engr., Bell Telephone Co. of Canada, Plateau Bldg., Montreal, Que. (*H*) 4857 Cumberland Ave. (*A.M. 1931*)

BAUMAN, Bert, B.Sc., (McGill '27), Constrn. Engr., Aluminum Co. of Canada, Ltd., Box 42, Arvida, Que. (*H*) Buckingham, Que. (*S. 1927*)

BAXTER, Gordon B., B.Sc., (McGill '26), Elec. Engr., Can. International Paper Co., Three Rivers, Que. (*H*) 860 Haut Boc St. (*S. 1924*) (*Jr. 1929*)

BAXTER, John G. M., B.I., (Prague '25), Dept. of Northern Development, North Bay, Ont. (*Jr. 1927*) (*A.M. 1929*)

♂BAYNE, Blair Edmundston, Lieut., B.Sc., (N.S.T.C. '22), Maintainer, C.N.R., Moncton, N.B. (*H*) 51 Cameron St. (*Jr. 1920*) (*A.M. 1927*)

BAYNE, Geo. Manning, Heating Engr'g. Divn., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 186 Rosslyn Ave. S. (*A.M. 1922*)

♂BEACH, Floyd K., Major, D.L.S., Petroleum Engr., Dept. of Lands and Mines, Alta., 102 Administration Bldg., Edmonton, Alta. (*H*) 10957–90th Ave (*S. 1910*) (*A.M. 1913*) (*M. 1935*)

BEACH, John E., B.Sc., (Alta. '35), Royalite Oil Co., Turner Valley, Alta (*H*) 10957–90th Ave., Edmonton, Alta. (*S. 1935*)

BEALE, Alfred M., B.Sc., (London), Water Power and Reclam. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) 12 Lisgar Rd., Rockcliffe, Ont. (*S. 1907*) (*A.M. 1912*)

BEAM, Donald C., B.A.Sc., (Tor. '28), Plan Examiner, Bldg. Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 191 Castlefield Ave (*S. 1926*) (*Jr. 1927*) (*A.M. 1935*)

BEAMENT, Geo. Edwin, (R.M.C., Kingston), B.A.Sc., (Tor. '31), Beament & Beament, Ottawa Electric Bldg., 56 Sparks St., Ottawa, Ont. (*H*) 9 Marlborough Ave. (*Jr. 1932*)

BEATH, Laurence Raymond, B.Eng., (McGill '35), Price Bros. & Co., Kenogami, Que. (*H*) 1545 Albert St., Regina, Sask. (*S. 1935*) (*Sec.-Treas., Saguenay Br., E.I.C.*)

BEATON, Neville, Res. Engr., Powell River Co. Ltd., Box 656, Powell River, B.C. (*A.M. 1935*)

BEATTY, James Edward, (R.M.C., Kingston), D.L.S., Engr., Mtce. of Way, C.P.R., Rm. 245, Windsor Sta., Montreal, Que. (*H*) 4850 Westmount Ave., Westmount, Que. (*A.M. 1905*) (*M. 1915*)

BEAUBIEN, deGaspe, B.Sc., (McGill '06), Cons. Engr., de Gaspe Beaubien & Co., Rm. 1104, University Tower, 660 St. Catherine St. W., Montreal, Que. (*H*) 462 St. Catherine Rd., Outremont, Que. (*S. 1903*) (*A.M. 1908*) (*M. 1921*)

BEAUCHEMIN, Alphonse O., B.A.Sc., Address unknown. (*S. 1907*) (*A.M. 1912*)

BEAUCHEMIN, Jules Armand, B.A.Sc., (Ecole Polytech., Montreal), Comptroller, Lake St. Louis Bridge Corp., Ville La Salle, Que. (*H*) 4417 Coolbrook Ave., Montreal, Que. (*A.M. 1919*)

BEAUDRY, Louis, B.A.Sc., (Ecole Polytech., Montreal '21), Designing Engr., Harbour Commrs. of Quebec, Quebec, Que. (*H*) 4 Laporte St. (*S. 1919*) (*A.M. 1926*)

BEAVERS, Geo. Robt., Chief Engr., Can. Blower and Forge Co., Kitchener, Ont. (*S. 1923*) (*Jr. 1927*)

BECK, Alfred Edward, B.Sc., (McGill '03), 275 Russell Hill Rd., Toronto, Ont. (*S. 1899*) (*A.M. 1907*)

BECK, Edward Alfred, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 106 Irvine Ave., Westmount, Que. (*A.M. 1920*)

BECK, Humphrey C., Contract Engr., Brown Boveri & Co., Baden, Switzerland. (*H*) Sandringham, Norfolk, England. (*A.M. 1934*)

BECKER, Donald Fay, Sec.-Treas., Richfield Distributors Ltd., 225-A 8th Ave. W. Calgary, Alta. (*Jr. 1935*)

BECKER, Fred A., B.A.Sc., (Tor. '24), Sales Engr., Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*Jr. 1928*) (*A.M. 1931*)

BECKER, Howard Warren, B.A., B.Sc., (Alta '33), Vice-Pres., Richfield Distributors Ltd., 225-A 8th Ave. W., Calgary, Alta. (*Jr. 1935*)

BEDFORD-JONES, Chas. E., 210 Somerset St. W., Ottawa, Ont. (*S. 1932*)

BEER, Alfred Netlam, 3821 Draper Ave., Montreal, Que. (*A.M. 1915*)

♂BEGG, Jas. M., B.Sc., (Glasgow), Greenbank, Cumnock, Ayrshire, Scotland. (*A.M. 1913*) (*M. 1928*)

BEIQUE, Paul A., B.A.Sc., (Ecole Polytech., Montreal), Q.L.S., Cons. Engr., 477 St. Francois Xavier St., Montreal, Que.; Vice-Pres., Montreal Tramways Comm. (*H*) 615 Dunlop Ave., Outremont, Que. (*S. 1904*) (*A.M. 1913*)

BELANGER, Alex. Albert, Div. Engr., Bd. Rly. Commrs. for Canada, Ottawa, Ont. (*S. 1899*) (*A.M. 1907*)

BELANGER, Raphael, B.Sc., (Ecole Polytech., Montreal '23), City Engr., Valleyfield, Que. (*H*) 47 Jacques Cartier St. (*S. 1921*) (*A.M. 1927*)

BELANGER, René, B.A.Sc., Supt., Quebec Pulp and Paper Corp., P.O. Box N., Chicoutimi, Que. (*H*) 53 Price St. (*A.M. 1935*)

BELL, Douglas E., B.A.Sc., (B.C. '28), (B.A.Sc., '35), Asst. Engr., Standard Oil Co. of B.C., 906 Marine Bldg., Vancouver, B.C. (*H*) 4544-W. 1st St. (*S. 1925*)

BELL, Fred'k. A., B.Sc., (Queen's '10), O.L.S., County Engr., and Gen. Practice, Court House, St. Thomas, Ont. (*H*) 2 Prince Albert St. (*S. 1906*) (*A.M. 1913*)

BELL, F. Jno., Mfrs. Representative, Royal Bank Bldg., Toronto, Ont. (*H*) 80 Highlands Ave. (*M. 1918*)

♂BELL, George Edward, Capt., B.Sc., (McGill '07), London Mgr., Deloro Smelting and Refining Co. Ltd., 14 Waterloo Place, London, S.W.1., England. (*H*) Northwood, Middlesex. (*S. 1901*) (*A.M. 1908*) (*M. 1914*)

BELL, Geo. M., B.Sc., (Man. '31), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) Apt. 5, 827 Main St. E. (*S. 1928*)

BELL, Harry H., B.Sc., (N.S.T.C. '29), S.M., (M.I.T. '33), Montreal Engineering Co., 244 St. James St., Montreal, Que. (*H*) 5549-47 Queen Mary Rd. (*S. 1928*) (*Jr. 1931*) (*A.M. 1934*)

♂BELL, Richard Thos., Chief Engr., Jaeger Truck Mixers (England) Ltd., 54 Victoria St., London, S.W.1, England. (*H*) Alexandra Court, Wembley, Middlesex. (*M. 1928*)

BELLAMY, Franklin J., Private Practice, 12 Mont LeGrand, Exeter, Devon, England. (*M. 1910*)

BELLAMY, Keith Lacy, B.Sc., (Queen's '35), 2548 Taylor St., Niagara Falls, Ont. (*S. 1934*)

BELLEW, Leo T. F., B.Eng., (McGill '34), Apt. 18, 4970 Queen Mary Rd., Montreal, Que. (*S. 1925*)

♂BELL-IRVING, Robt., Capt., B.Sc., (McGill '14), B.C.L.S., Asst. Gen. Mgr., Powell River Co., Ltd., Standard Bank Bldg., Vancouver, B.C. (*H*) 1646 Laurier Ave. (*A.M. 1920*)

BELLIVEAU, John Edmund, Asst. Chief Engr., Dept. of Highways, N.S., Halifax, N.S. (*H*) 33 Vernon St. (*A.M. 1918*)

BEMAN, Edwin Arthur, B.E., (Sask. '28), 254 Cathedral Ave., Winnipeg, Man. (*A.M. 1931*)

BENEDICT, Elmore M., 51 W. 39th St., Bayonne, N.J. (*S. 1907*) (*A.M. 1913*)

BENETT, Chas. Morgan, B.Sc., (McGill '23), 22 Chesterfield Ave., Westmount, Que. (*A.M. 1934*)

BENJAFIELD, G., B.Sc., (Queen's '32), 39 Wellington St., St. Thomas, Ont. (*S. 1928*)

BENJAFIELD, J. F., B.Sc., (Queen's '33), Instr'man. City of St. Thomas, Ont. (*H*) 39 Willington St. (*S. 1933*)

BENJAMIN, Abraham, B.Sc., (McGill '24), Design Engr., Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) Apt. 7, 1080 Lajoie Ave. (*S. 1921*) (*Jr. 1928*)

BENJAMIN, Archie, B.Sc., (McGill '28), Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 877 Dollard Ave., Outremont, Que. (*S. 1926*) (*Jr. 1933*)

♂BENNET, W. Herbert, Lieut., B.Sc., (Queen's '19), Engr., Technical Service, City of Montreal, City Hall, Montreal, Que. (*H*) 3453 Rosedale Ave. (*S. 1919*) (*Jr. 1922*) (*A.M. 1924*)

BENNETT, Arthur J., B.Sc., (McGill '27), Sales Engr., English Electric Co. of Canada, Ltd., 1124 University Tower, 660 St. Catherine St. W., Montreal, Que. (*S. 1925*)

♂BENNETT, Chas. S., Lieut., B.Sc., (N.B. '12), Acting Chief Engr., Halifax Harbour Comm., Halifax, N.S. (*H*) 318 Barrington St. (*Jr. 1914*) (*A.M. 1927*)

BENNETT, Geo. Arthur, B.A.Sc., C.E., (Tor. '10), D.L.S., A.L.S., 47 McLeod St., Ottawa, Ont. (*A.M. 1922*)

BENNETT, Geo. Francis, B.Sc., (McGill '31), Sales Engr., Can. Westinghouse Co., Ltd., 158 Granville St., Halifax, N.S. (*S. 1929*)

♂BENNETT, Harry Frederick, Capt., B.Sc., (N.B. '08), Dist. Engr., D.P.W., Canada P.O. Bldg., Sault Ste. Marie, Ont. (*S. 1907*) (*Jr. 1914*) (*A.M. 1920*) (*M. 1935*)

BENNETT, Robt. D., B.Eng., (McGill '32), M.Sc. '33; Ph.D., Director of Research, Can. Industrial Alcohol Co., Corbyville, Ont. (*H*) 4401 Harvard Ave., Montreal, Que. (*S. 1930*)

♂BENNETT, Stewart Gordon, Capt., M.C., B.A.Sc., (Tor. '14), Vice-Pres., Beardmore & Co., 37 Front St. E., Toronto, Ont. (*H*) 4 Dale Ave. (*A.M. 1926*)

BENNY, Walter R., B.Eng., (McGill '32), Box 265, Schreiber, Ont. (*S. 1928*)

BENNY, Walter W., B.A.Sc., (McGill '98), P.O. Box 265, Schreiber, Ont. (*S. 1899*) (*A.M. 1904*)

BENOIT, Andre Persillier, B.Eng., (McGill '34), 481 Prince Arthur St. W., Montreal, Que. (*S. 1933*)

BENOIT, Jacques, B.A.Sc., (Ecole Polytech., Montreal '33), Asst. Dist. Mgr., Wallace & Tiernan Ltd., 811 New Birks Bldg., Montreal, Que. (*H*) 481 Prince Arthur St. W. (*S. 1933*)

BENSON, Willard McLean, B.Sc., (N.B. '35), 83 Shore St., Fredericton, N.B. (*S. 1935*)

BENTLEY, Kenneth Earl, B.Sc., (N.S.T.C. '34), Imperial Oil Co., Imperoyal, N.S. (*H*) 23 Tulip St., Dartmouth, N.S. (*S. 1934*)

BERENSTEIN, Leslie, B.Sc., (McGill '30), Str'l. Engr., Louis Pickard & Co. Inc., 2070 Papineau Ave., Montreal, Que. (*H*) 3785 Girouard Ave. (*S. 1929*)

BERGER, B. A., B.Sc., (McGill '30), Designing Dftsman., Ford Motor Co. of Canada, Windsor, Ont. (*H*) 94 Windermere Rd., Walkerville, Ont. (*S. 1928*)

BERLINGUET, F. X. T., D.L.S., P.L.S., Q.L.S., Cons. Engr., D.P.W., Three Rivers, Que. (*H*) 747 Laviolette Ave. (*A.M. 1887*) (*M. 1890*) (*Life Member*)

BERLYN, M. J., M.A., (Cantab. '25), Tech. Asst., Hydr. Dept., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 4870 Cote des Neiges Rd. (*A.M. 1930*)

BERRINGER, O. B., B.Sc., M.E., (N.S.T.C. '32 and '35), Lunenburg, N.S. (*S. 1933*)

♂BERRY, Albert Edward, Lieut., C.E., M.A.Sc., (Tor.), Ph.D., Director, Sanitary Engrg. Divn., Dept. of Health, Ont., Parliament Bldgs., East Blk., Toronto, Ont. (*H*) 235 Gainsborough Rd. (*A.M. 1921*) (*M. 1934*)

BERRY, Effingham Deans, (R.T.C., Glasgow), Chief Dftsman., E. B. Eddy Co. Ltd., Hull, Que. (*H*) 150 Aylmer Ave., Ottawa, Ont. (*A.M. 1933*)

BERRY, Theodore Victor, B.A.Sc., (B.C. '23), Sec.-Treas., Vancouver and Dists., Joint Sewerage and Drainage Bd., 1303 Bekins Bldg., Vancouver, B.C. (*H*) 3007-W. 36th Ave. (*A.M. 1934*)

BERTRAM, H. Graham, B.Sc., (Queen's '10), Vice-Pres. and Gen. Mgr., The John Bertram & Sons Co., Ltd., Dundas, Ont., and Pratt & Whitney Co. of Canada, Ltd., Dundas, Ont. (*M. 1920*)

BERTRAND, G., 178 Ave. Daumesnil, Paris 12, France. (*S. 1928*)

BERTRAND, J. N. Tetu, B.A., (Laval '83), Isle Verte, Que. (*S. 1897*) (*A.M. 1906*) (*Life Member*)

BEUGLER, Edwin James, Cons. Engr., Private Practice, South Main St., Cheshire, Conn. (*M. 1907*)

♂BEVAN, William Henry Basil, A/Major D.C.M., Asst. Dist. Engr., C.N.R., Rm. 1405, C.N. Express Bldg., Toronto, Ont. (*H*) 11 Lawrence Crescent. (*A.M. 1921*)

♂BEWS, Douglas Waldron, B.Sc., (Queen's '14), Dfting. Instructor, Belleville Technical School. (*H*) 184 Albert St., Belleville, Ont. (*Jr. 1916*) (*A.M. 1921*)

♂BICKERDIKE, Robt., Lieut.-Col., D.S.O., Ma.E., (McGill '91), 4384 Harvard Ave., Montreal, Que. (*S. 1888*) (*A.M. 1895*) (*M. 1900*)

BICKLE, Warner Pentland, B.Sc., (Man. '24), Supt., Acadia Construction Co. Ltd., 101 Upper Water St., Halifax, N.S. (*A.M. 1930*)

BIELER, Jacques Louis, B.Sc., (McGill '23), Asst. Engr., Dom. Oilcloth and Linoleum Co., Montreal, Que. (*H*) 643 Milton St. (*S. 1920*) (*Jr. 1928*)

BIESENTHAL, Clarence G., 362 Christie St., Pembroke, Ont. (*S. 1935*)

BILLETTE, Roger, B.Eng., (McGill), Shawinigan Water and Power Co., Three Rivers, Que. (*H*) 549 Bonaventure St. (*S. 1931*)

BILLIE, Frank R. V., B.A., (Laval), B.Sc., (McGill '27), P.O. Box 1185, Smith's Falls, Ont. (*S. 1927*)

BILLINGS, A. W. K., A.M., (Harvard '96), Vice-Pres., Brazilian Traction, Light and Power Co., Ltd. and Subsidiaries, 25 King St. W., Toronto, Ont. (*M. 1930*)

BINGHAM, Albert R., 307–7th Ave. N.E., St. Petersburg, Fla. (*A.M. 1921*)

♂BIRD, Frederick George, Major, M.C., B.Sc., (Queen's '14), 606–2nd St. W., Calgary, Alta. (*A.M. 1920*)

♂BIRD, Hubert John, Capt., Pres. and Gen. Mgr., Bird Construction Co. Ltd., Bank of Montreal Bldg., Moose Jaw, Sask. (*H*) 1122 Redland Ave. (*A.M. 1929*)

♂BIRKETT, Leonard Harris, Sales Mgr., Combustion Engineering Corp. Ltd., Dominion Square Bldg., Montreal, Que. (*H*) 4690 Roslyn Ave. (*A.M. 1927*)

♂BIRRELL, Allan Lloyd, Cons. Elec. and Mech. Engr., Allan L. Birrell, 372 Bay St., Toronto 2, Ont. (*H*) 93 Kingsway. (*A.M. 1921*)

♂BISHOP, Arthur Leonard, Col., (R.M.C., Kingston '14), Pres., The Coniagas Mines, Ltd., 1514 Canada Permanent Bldg., Toronto, Ont. (*H*) 69 Forest Hill Rd. (*Jr. 1919*) (*A.M. 1924*)

BISHOP, William Israel (*q*), Pres., William I. Bishop, Ltd., New Birks Bldg., Montreal, Que. (*H*) 454 Elm Ave., Westmount, Que. (*S. 1896*) (*A.M. 1899*) (*M. 1907*)

BISHOP, Wm. J., Prin. Asst. Engr., Dept. of Northern Development, White River, Ont. (*H*) 352 McLaren St., Ottawa, Ont. (*S. 1909*) (*A.M. 1911*)

BISSETT, James Randolph, B.Sc., (Tor. '12), Sr. Asst. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) 24 Driveway. (*A.M. 1916*)

BIZIER, Jos. Lionel, B.A.Sc., (Ecole Polytech., Montreal '27), Asst. Engr., Quebec Harbour Comm., Quebec, Que. (*H*) 59 Murray Ave. (*A.M. 1931*)

BLACHFORD, H. E., B.Sc., (McGill '31), 7 Hudson Ave., Westmount, Que. (*S. 1930*)

BLACK, E. A., B.A.Sc., (Tor. '32), 310 Russell Hill Rd., Toronto, Ont. (*S. 1932*)

BLACK, Frank Leslie, B.Sc., (N.S.T.C. '31), Asst. Prof. Engrg., Mt. Allison University, Sackville, N.B. (*H*) 169 Cornhill St., Moncton, N.B. (*S. 1930*) (*Jr. 1934*)

BLACK, Hugh Murray, B.Sc., (McGill '23), Dist. Mgr., English Electric Co. Ltd., 330 Bay St., Toronto, Ont. (*H*) 50 Chudleigh Ave. (*S. 1921*) (*A.M. 1930*)

BLACK, John Alfred, B.Sc., (N.S.T.C. '30), Mill Supt., Perron Gold Mines, Ltd., Pascalis, Que. (*S. 1929*) (*A.M. 1934*)

BLACK, Maurice W., Canada Construction Co., Ltd., Royal Bank Bldg., Fredericton, N.B. (*H*) 170 Waterloo Row. (*S. 1907*) (*Jr. 1912*) (*A.M. 1916*) (*M. 1922*)

BLACK, S. W. Bruce, B.A.Sc., (Tor. '13), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 88 St. Germain Ave. (*A.M. 1920*)

BLACK, Wm. D., B.A.Sc., (Tor. '09), Pres., Otis-Fensom Elevator Co., Ltd., Hamilton, Ont. (*H*) 454 Queen St. S. (*S. 1908*) (*A.M. 1912*) (*M. 1928*)

BLACKBURN, Robt. Neale, "Katepwa," Ashfield Park Ave., Ross-on-Wye, England. (*M. 1920*) (*Life Member*)

BLACKETT, Victor St. Clair, B.Sc., (McGill '10), Asst. Engr., Chief Engrs.' Office, C.N.R., Moncton, N.B. (*H*) 229 Highfield St. (*A.M. 1921*) (*Sec.-Treas., Moncton Br., E.I.C.*)

BLACKMORE, C. L., B.Sc., (McGill '27), Rm. 418, 1118 St. Catherine St. W., Montreal, Que. (*S. 1925*) (*Jr. 1930*)

BLADON, James Buckley, Chief Engr., Darling Bros., Ltd., Montreal, Que. (*H*) 85 Holton Ave., Westmount, Que. (*M. 1922*)

BLAIKLOCK, Morris S., 1321 Sherbrooke St. W., Montreal, Que. (*M. 1909*)

BLAINE, D. S., (R.M.C., Kingston '32), B.Sc., (Queen's '34), F./O., R.C.A.F. Station, Trenton, Ont. (*H*) 9720–106th St., Edmonton, Alta. (*S. 1934*)

BLAIR, David E., B.Sc., (McGill '97), Gen. Supt., Montreal Tramways Co., Montreal, Que. (*H*) 752 Upper Lansdowne Ave., Westmount, Que. (*A.M. 1904*) (*M. 1927*)

BLAIR, Donald, Strl. Engr., Dept. of National Defence, Rm. 507, Canadian Bldg., Ottawa, Ont. (*H*) 173 Daly Ave. (*A.M. 1934*)

♂BLAIR, Fager Jas., Lieut., (Tor. '10), Wks. Engr., Toronto Harbour Comm., Toronto, Ont. (*H*) 91 Alexander Blvd. (*A.M. 1921*)

BLAIR, Jas., Asst. Refinery Engr., Imperial Oil Ltd., E. Calgary, Alta. (*H*) 118–18th Ave. E. (*S. 1931*)

♂BLAIR, Robert Thomson, Lieut., (R.T.C., Glasgow), Building Dept., City Hall, Vancouver, B.C. (*H*) 6062 McDonald St. (*A.M. 1921*)

BLAIR-McGUFFIE, M. H., B.Eng., (McGill '35), Canadian Industries Ltd., Montreal, Que. (*H*) 517 Pine Ave. W. (*S. 1934*)

BLAKE, Jas. Hewat, Mech. Supt., Dept. of Lands, B.C., Parliament Bldg., Victoria, B.C. (*H*) 1282 Kings Rd. (*A.M. 1923*)

♂BLAKE, Wm. Henry, Capt., M.C., R.C.E., D.E.O., M.D. No. 7, Dept. National Defence, The Armoury, Saint John, N.B. (*H*) 81 Orange St. (*A.M. 1931*)

†BLANCHARD, A. C. D., B.Sc., (McGill '01), Engr., Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*H*) 8027 Western Ave. (*S. 1901*) (*A.M. 1904*) (*M. 1911*)

BLANCHARD, Arthur Horace, C.E., M.A., Cons. Highway Engr., Box C., Edgewood Station, Providence, R.I. (*M. 1912*)

BLANCHARD, C. Haliburton, Dist. Engr., Reclam. Branch, Man. D.P.W., Legislative Bldg., Winnipeg, Man. Dist. office: Garson, Man. (*A.M. 1919*)

BLANCHARD, Joseph Elie, Director of P.W., City of Montreal, City Hall, Montreal, Que. (*H*) 11930 Valmont St. (*M. 1920*)

BLANCHET, Paul Maurice, B.Sc., (McGill '30), Rothesay, N.B. (*S. 1930*)

BLOOM, David, B.Eng., '35, 660 Querbes Ave., Outremont, Que. (*S. 1935*)

BLOOMFIELD, Jas. M., Supt. of Utilities, Town of Kamsack, Kamsack, Sask. (*A.M. 1929*)

BLUE, Albert C., B.A.Sc., (Tor. '21), Mgr., Wks. and Engrg., Riley Engineering and Supply Co., Ltd. (*H*) 7 Thairs Ave., St. Catharines, Ont. (*S. 1920*) (*Jr. 1927*) (*A.M. 1932*)

♂BLUE, Walter Edgar, Major, D.S.O., (R.M.C., Kingston '10), Mgr., Dev. Dept., Gatineau Power Co., Ottawa, Ont. (*H*) 638 Rideau St., Ottawa, Ont. (*S. 1910*) (*Jr. 1913*) (*A.M. 1919*)

†BLUMENTHAL, Samuel, B.Sc., (McGill '04), Asst. Engr., Bridge Dept., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 63 Strathearn Ave., Montreal West. (*S. 1903*) (*A.M. 1909*)

BOAST, C. W., B.Sc., C.E., (McGill '17), Plant Engr., Spruce Falls Power and Paper Co., Ltd., Kapuskasing, Ont. (*S. 1917*) (*A.M. 1922*)

BOAST, Richard G., B.Sc., C.E., (McGill '11), Engr. Mtce. of Way, T. & N.O. Rly., North Bay, Ont. (*H*) 96 Ferguson St. (*S. 1908*) (*Jr. 1912*) (*A.M. 1922*)

BODWELL, G. L., R.M.C., Kingston, Ont. (*S. 1935*)

BODWELL, Harold A., Str'l. Engr., Toronto Hydro-Electric System, Toronto, Ont. (*H*) 37 Columbine Ave. (*M. 1921*)

BOESE, Geo. P. F., Asst. Engr., Dept. of Nat. Res., C.P.R., Calgary, Alta. (*S. 1909*) (*A.M. 1919*)

BOESE, P. Raymond, N.Y.C. R.R., Rm. 914, 466 Lexington Ave., New York, N.Y. (*S. 1909*) (*Jr. 1914*) (*A.M. 1922*)

♂BOGART, J. L. H., Col., D.S.O., (R.M.C., Kingston), B.Sc., (Queen's '03), Camp Engr., Dept. of National Defence, Petawawa, Ont. (*A.M. 1902*)

BOISSONNAULT, Bertrand O., B.Sc., (McGill '30), Engr., Industrial and Commercial Laboratories, Ltd., Montreal, Que. (*H*) 32 Robert Ave., Outremont, Que. (*S. 1928*)

BOISVERT, Chas. H., C.E., (Ecole Polytech., Montreal '26), Quebec Public Service Comm., Court House, Quebec, Que. (*H*) 49 Laurentides Ave. (*Jr. 1927*) (*A.M. 1932*)

BOIVIN, Thos. J., Asst. Engr., Eastern Canada Steel and Irôn Works, Ltd., Quebec, Que. (*H*) 189 Holland Ave. (*A.M. 1929*)

♂BOLGER, Edmund Jos., Major, Mine Supt., Ardeem Gold Mines Ltd., Top Top Spur, Port Arthur, Ont. (*S. 1904*) (*Jr. 1911*) (*A.M. 1915*)

BOLTON, Launcelot Lawrence, M.A., B.Sc., (Queen's '06), Asst. Deputy Minister, Dept. of Mines, Ottawa, Ont. (*H*) 76 Fentiman Ave. (*M. 1926*)

BONAVENTURE, Jos. Eugene, B.A.Sc., (Ecole Polytech. '14), Asst. Engr., D.P.W., Box 407, Three Rivers, Que. (*H*) 74 Rue Chateau. (*A.M. 1928*)

♂BOND, Frank Lorn Campbell, Major, D.S.O., B.Sc., (McGill '98), Gen. Supt., Montreal Dist., C.N.R., 891 Notre Dame St. W., Montreal, Que. (*H*) 3548 Mountain St. (*S. 1898*) (*A.M. 1902*) (*M. 1919*)

♂BOND, James R., Capt., Supt'g. Engr., Niagara Parks Comm., Niagara Falls, Ont. (*H*) Chippawa, Ont. (*A.M. 1920*)

BONE, Allan Turner, B.Sc., (McGill '16), Vice-Pres., J. L. E. Price & Co. Ltd., 1135 Beaver Hall Hill, Montreal, Que. (*H*) 46 Summit Circle, Westmount, Que. (*A.M. 1922*)

BONE, P. Turner, 340–4th Ave. West, Calgary, Alta. (*M. 1914*)

♂BONHAM, Robert Lincoln, Lieut., B.Sc., (Queen's '21), Supt. of Operation, Western Region, Canada Creosoting Co., Ltd., 1910–9th Ave. W., Calgary, Alta. (*H*) 2401 Carlton St. (*Jr. 1921*) (*A.M. 1930*)

BONN, Wm. Ernest, Div'l. Engr., Can. Dredging Co. Ltd., and Can. Dredge and Dock Co., 302 Harbour Commrs. Bldg., Toronto, Ont. (*H*) 215 Richview Ave., Forest Hill Village. (*Jr. 1914*) (*A.M. 1918*) (*M. 1935*)

BONNELL, A. Robertson, B.Sc., (N.B. '35), Box 297, Sussex, N.B. (*S. 1935*)

BONNELL, M. B., B.Sc., (Tor. '05), Patent Examiner, Dom. Govt. Patent Office, Ottawa, Ont. (*H*) 378 Elgin St. (*A.M. 1922*)

BONNEY, Albert J., B.Sc., (Queen's '35), The Quaker Oats Co., Peterborough, Ont. (*H*) 711 Water St. (*S. 1935*)

BONNYCASTLE, Wm. Robinson, 2535 Marine Drive W., Vancouver, B.C. (*M. 1917*)

BOOKER, G. Ernest, P.O. Box 681, New Liskeard, Ont. (*A.M. 1918*)

BOOTH, Mark Westaway, Steam Engr., Dom. Steel and Coal Corp. Ltd., Sydney, N.S. (*H*) 160 Whitney Ave. (*A.M. 1921*) (*M. 1926*)

BOSTOCK, Wm. Norman, (R.M.C., Kingston), B.Sc., (McGill '25), Capt. R.C.E., Dept. National Defence, Work Point Barracks, Esquimalt, B.C. (*S. 1925*) (*A.M. 1935*)

BOSWELL, Elias John, (Tor. '95), O.L.S., D.L.S., L.S., H.E.P.C. of Ont., Toronto, Ont. (*H*) 249 Sheldrake Blvd. (*S. 1897*) (*A.M. 1900*)

BOUCHER, Raymond, B.A.Sc., (Ecole Polytech., Montreal '33), M.Sc., Asst. Prof. of Hydraulics, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*H*) 4114 St. Denis St. (*S. 1932*) (*Jr. 1934*)

BOULTON, Beverley Knight, B.Sc., (McGill '25), Supt. of Oper., Beauharnois L.H. and P. Cons., P.O. Box 100, Beauharnois, Que. (*S. 1923*) (*Jr. 1930*) (*A.M. 1931*)

BOURBONNAIS, Paul Emile, B.A., B.A.Sc., (Ecole Polytech., Montreal '14), Asst. Chief Engr., Quebec Streams Comm., Rm. 222, New Court House, Montreal, Que. (*H*) 1570 St. Joseph Blvd. E. (*A.M. 1928*)

BOURNE, Herbert Frederick, Municipal Engr., Esquimalt, B.C. (*H*) 941 Clent St. (*A.M. 1925*)

BOURQUE, Louis Philippe, B.Eng., (McGill '33), Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*S. 1933*)

BOUTILIER, Fred. Thomas, B.Sc., (N.S.T.C. '28), Mech. Staff, Aluminum Co. of Canada, Ltd., Arvida, Que. (*S. 1928*)

♂BOWDEN, Harold Arthur, Lieut., Div. Engr., C.N.R., Edmonton, Alta. (*A.M. 1920*)

BOWEN, Henry Blane, Chief of Motive Power and Rolling Stock, C.P.R. Co., Rm. 1000, Windsor Station, Montreal, Que. (*H*) 3018 Bresley Rd. (*M. 1935*)

BOWEN, J. A. C., B.A.Sc., (Tor. '35), Res. Engr., Dufferin Paving Co. Ltd., Toronto, Ont. (*H*) 70–36th, Long Branch, Ont. (*S. 1932*) (*Jr. 1934*)

BOWEN, Sydney, (A.C.G.I.), 97 Pine St. N., Thorold, Ont. (*A.M. 1919*)

BOWER, J. H. W., B.A.Sc., (Tor. '14), Supt., The Hospital for Sick Children, 67 College St., Toronto, Ont. (*H*) 41 Glengowan Rd. (*A.M. 1923*)

BOWLES, Wm. Shedden, B.Sc., (McGill '30), Asst. to Mgr., Can. Stebbins Engrg. and Mfg. Co. Ltd., 609 Drummond Bldg., Montreal, Que. (*H*) 12 Park Place, Apt. 5, Westmount, Que. (*S. 1929*) (*Jr. 1935*)

BOWMAN, Alex. John Maclean, Vice-Pres. and Gen. Mgr., Cross Supplies and Paving Ltd., 924 Windsor Ave., Windsor, Ont. (*H*) 298 Kildare Rd., Walkerville, Ont. (*A.M. 1920*)

BOWMAN, Chas. A., Editor, *The Citizen*, Southam Publishing Co., Ltd., Ottawa, Ont. (*H*) 446 Cloverdale Rd., Rockcliffe. (*A.M. 1923*)

♂BOWMAN, Edgar Peterson, Lieut., B.A.Sc., (Tor. '11), O.L.S., D.L.S., Private Practice, 341 Waterloo Ave., Guelph, Ont. (*A.M. 1912*)

♂BOWMAN, Frederick, Lieut., (Tor. '11), Dom. Bridge Co. Ltd., Montreal, Que. (*S. 1911*) (*Jr. 1916*) (*A.M. 1923*)

†BOWMAN, Fred. A., M.A., B.E., (King's, Halifax), Staff Engr., Maritime Telegraph and Telephone Co., Ltd., Box 110, Halifax, N.S. (*H*) 10 Connaught Ave. (*S. 1887*) (*A.M. 1891*) (*M. 1905*) (*Life Member*)

BOWMAN, Nelson, B.A.Sc., (Tor. '21), 726 E. 5th Ave., Owen Sound, Ont. (*S. 1920*) (*Jr. 1922*) (*A.M. 1927*)

BOWMAN, R. F. Patrick, B.Sc., (Alta. '28), Roadmaster, C.P.R., Lethbridge, Alta. (*H*) 6 Connaught Mansions. (*S. 1926*) (*Jr. 1930*) (*A.M. 1935*)

BOWN, C. Roy, B.Sc., (McGill '23), Asst. to Chief Engr., Canada and Dom. Sugar Co., 1410 Montmorency St., Montreal, Que. (*H*) 5404 Clanranald Ave. (*S. 1921*) (*Jr. 1925*)

BOWN, W. E., B.Sc., (McGill '23), Asst. Gen. Supt., British Empire Steel Corp., Sydney, N.S. (*H*) 11 Tain St. (*S. 1921*) (*A.M. 1930*)

BOWNESS, Ernest W., B.Sc., (McGill '05), Vice-Pres. i/c Operations, Canadian Utilities Corp., Can. Western Nat. Gas L.H. and P. Co.; North Western Utilities Ltd. Address: 215–6th Ave. W., Calgary, Alta. (*S. 1908*) (*A.M. 1910*) (*M. 1926*)

BOWNESS, Frank, Chief Dftsman., Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 273 Rubidge St. (*A.M. 1922*)

BOYD, Charles Stanley, B.Sc., (Queen's '17), Chief Dftsman., Horton Steel Works, Box 209, Fort Erie North, Ont. (*S. 1917*) (*A.M. 1921*)

BOYD, Harold Cecil Traynor, B.A., M.A., (Cantab.), 4650 St. Catherine St. W., Montreal, Que. (*A.M. 1932*)

♂BOYD, J. W. Gamble, Flt. Lieut., Dftsman., Aluminum Co. of Canada, Sterling Rd., Toronto, Ont. (*H*) 37 Hilton Ave. (*Jr. 1922*)

BOYER, Aurelien (*g*), B.A.Sc., Principal, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*H*) P.O. Box 550, St. Jerome, Que. (*A.M. 1899*)

BOYER, Marc, B.Sc., (Ecole Polytech., Montreal '28), Inspr. of Mines, Quebec Bureau of Mines, Quebec, Que. (*H*) 304 Laurier Ave. (*S. 1927*) (*A.M. 1934*)

BOYLE, Robt. Wm., M.Sc., M.A., Ph.D., (McGill), Director, Divn. of Physics and Engrg., National Research Council, Canada, Ottawa, Ont. (*H*) 25 Buena Vista Rd., Rockcliffe. (*M. 1924*)

♂BRACE, James H., Major, B.Sc., C.E., (Wis.), Vice-Pres., Fraser Brace Engineering Co. Ltd., 107 Craig St. W., Montreal, Que. (*H*) 637 Carleton Ave., Westmount, Que. (*M. 1916*)

BRACKEN, W. D., B.Sc., (Queen's '23), Asst. Supt., Can. Niagara Power Co. Ltd., Niagara Falls, Ont. (*H*) 1975 Drummond Rd. (*S. 1922*) (*A.M. 1933*)

BRADDELL, E. S. P., B.Sc., (Man. '32), Winnipeg Electric Corp., Electric Rly. Chambers, Winnipeg, Man. (*H*) 104 Chestnut St. (*S. 1931*)

BRADFIELD, John Ross, B.Sc., (McGill '22), Plant Engr., Noranda Mines, Ltd., Noranda, Que. (*S. 1921*) (*Jr. 1927*) (*A.M. 1933*)

♂BRADLEY, Jas. Harrison, Lieut., Holcroft & Co., Contracting Engrs., 6545 Epworth Blvd., Detroit, Mich. (*H*) 14014 Grandmont Rd. (*A.M. 1917*)

BRADLEY, Nicholas Hillburn, D.L.S., A.L.S., Dist. Engr., D.P.W., Lethbridge, Alta. (*H*) 631–14th St. S. (*A.M. 1922*)

BRADLEY, Robt. Auldon, Welland Ship Canal, St. Catharines, Ont. (*H*) 23 Catharine St. (*Jr. 1927*) (*A.M. 1930*)

BRADSHAW, Frederick W., B.Sc., (McGill '25), Dev. Engr., Research and Tech. Dept., Cons. Paper Corp. Ltd., Three Rivers, Que. (*H*) 834 Notre Dame St. (*S. 1920*) (*Jr. 1925*) (*A.M. 1929*)

BRAIN, Cecil, B.Sc., (McGill '28), Inter. Power and Paper Co., Corner Brook, Nfld. (*H*) 3 Armstrong Ave. (*S. 1927*) (*Jr. 1929*)

BRAINE, Arthur Wentworth, B.Sc., (N.B. '31), 3800 Dewdney Ave., Regina, Sask. (*S. 1933*)

BRAKENRIDGE, Charles, (R.T.C., Glasgow), City Engr., City Hall, Vancouver, B.C. (*H*) 3450–3rd Ave. W. (*A.M. 1915*) (*M. 1919*)

♂BRANCH, Alec J., Water Master, Lethbridge Northern Irrigation Dist., Lethbridge, Alta. Address: Box 395, Picture Butte, Alta. (*A.M. 1925*)

BRANCHAUD, Henri, 636 Dunlop Ave., Outremont, Que. (*S. 1935*)

BRANDON, Edgar T. J., B.A.Sc., (Tor. '02), Chief Elec. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 301 Indian Rd. (*S. 1904*) (*A.M. 1911*)

BRANDON, Harry Elmer, B.A.Sc., (Tor. '07), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 447 Blythwood Rd. (*A.M. 1926*)

BRANNEN, Edwin Ralph, B.Sc., (N.B. '35), North Devon, N.B. (*S. 1935*)

BRANT, Theodore J., B.A.Sc., (Tor. '29), 678 Bethune St., Peterborough, Ont. (*Jr. 1932*)

BRAULT, Paul G. A., B.Sc., (McGill '21), Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 4913 Patricia Ave., Montreal, Que. (*S. 1920*) (*A.M. 1927*)

BRAUNS, Otto L. J., (R.T.C. Stockholm '28), Asst. Chemist, Abitibi Power and Paper Co., Sault Ste. Marie, Ont. (*H*) 112 Andrews St. (*A.M. 1934*)

BRAY, Samuel, C.E., O.L.S., D.L.S., Chief Surveyor, Dept. Indian Affairs, Ottawa, Ont. (*H*) 229 Argyle Ave. (*M. 1909*) (*Life Member*)

BRAZIER, Henry Arthur, Prop., H. A. Brazier Constrn. Co. Ltd., 476 Richmond St., London, Ont. (*H*) 320 Grosvenor St. (*A.M. 1915*) (*M. 1922*)

BREAKEY, Jas., Editor, "Modern Power and Engineering," MacLean Publishing Co., Toronto, Ont. (*H*) 44 Brentwood Rd., Substa. 82, Toronto 3, Ont. (*Jr. 1931*) (*A.M. 1935*)

BREED, Chas. B., B.S., (M.I.T. '97), Head of Dept. of Civil and Sanitary Engrg., Mass. Inst. of Tech., Cambridge, Mass. (*H*) 32 Harvard St., Newtonville, Mass. (*M. 1930*)

♂BREEN, Jos. Melville, B.A.Sc., (Tor. '21), Chief of Tech. Staff, Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. (*H*) 65 Kennedy Park Rd., Toronto, Ont. (*A.M. 1924*)

BREHAUT, H. B., B.Sc., (Sask. '27), Manitoba Bridge and Iron Wks. Ltd., Winnipeg, Man. (*H*) Ste. 7, Bellcrest Apts. (*S. 1927*) (*A.M. 1928*)

♂BREITHAUPT, Carl Louis, B.A.Sc., (Tor. '22), 172 Margaret Ave., Kitchener, Ont. (*S. 1921*) (*A.M. 1925*)

BREITHAUPT, Philip Wm., C.E., (Renss. '22), 10 Duke St. E., Kitchener, Ont. (*A.M. 1932*)

†BREITHAUPT, Wm. Henry, C.E., (Renss.), Cons. Engr., 15 Queen St. N., Kitchener, Ont. (*H*) 66 Margaret Ave. (*M. 1903*) (*Life Member*)

BREMNER, Douglas, B.Sc., (McGill '15), Pres. and Man. Dir., Bremner, Norris & Co. Ltd., 2049 McGill College Ave., Montreal, Que. (*H*) 3769 The Boulevard, Westmount, Que. (*S. 1914*) (*A.M. 1917*) (*M. 1928*)

BRERETON, Wilfred Proctor, B.A.Sc., (Tor. '03), City Engr., City Hall Annex, Winnipeg, Man. (*H*) 1015 Grosvenor Ave. (*A.M. 1908*) (*M. 1918*)

♂†BRETT, John Francis, Lieut., Divn. Engr., Montreal Water Board, 3161 St. Joseph St., Verdun, Que. (*H*) 4180 Melrose Ave., Montreal, Que. (*S. 1914*) (*Jr. 1919*) (*A.M. 1920*)

BREWER, Douglas Jared, B.Sc., (N.B. '35), 269 Woodstock Rd., Fredericton, N.B. (*S. 1935*)

BREWER, H. B., B.Sc., (N.B. '28), Supt. of Fertilizer Dept., Can. Industries Ltd., McMasterville, Que. (*Jr. 1930*)

BRICAULT, L., 4312 Delorimier Ave., Montreal, Que. (*S. 1935*)

♂BRICKENDEN, Frederick M., Capt., (Tor.), 228 Home St., Winnipeg, Man. (*S. 1910*) (*Jr. 1913*) (*A.M. 1918*)

♂BRICKENDEN, Wm. Thos., B.A.Sc., (Tor. '22), Mech. Engr., Thorne, Mulholland, Howson & McPherson, 1018 Federal Bldg., Toronto, Ont. (*H*) 301 Silverbirch Ave. (*Jr. 1923*) (*A.M. 1931*)

BRIDGE, David E., B.Sc., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. W. (*S. 1930*)

BRIDGE, J. Franklin, B.A.Sc., (Tor. '25), Asst. Mgr., Salt Plant, Can. Industries Ltd., Windsor, Ont. (*H*) 1375 Victoria Ave. (*A.M. 1934*)

BRIDGES, Ernest T., Operating Mgr., Ont. Divn., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 290 High Park Ave. (*A.M. 1921*)

BRIDGES, Frederick, Cons. Engr., 24 Phipps St., Sorel, Que. (*M. 1930*)

BRIDGLAND, Chas. J., B.A.Sc., (Tor. '33), M.A.Sc. '34, 25 Gothic Ave., Toronto, Ont. (*S. 1933*)

BRIDGLAND, Morrison Parsons, B.A., (Tor. '01), D.L.S., Topographical Survey of Canada, Calgary, Alta. (*H*) 1950–13th St. W. (*M. 1927*)

♂BRIERCLIFFE, Henry C. D., B.Sc., (McGill '11), Private Practice, 201 Ash St., Winnipeg, Man. (*A.M. 1919*)

BRIETZCKE, Edmund H., Sr. Asst. Engr., Harbour Commrs. of Montreal, 357 Common St., Montreal, Que. (*H*) 31 Springfield Ave., Westmount, Que. (*A.M. 1910*)

BRIGGS, Herbert Lee, B.Sc., (Man. '28), Relay Engr., City of Winnipeg Hydro Electric System, Winnipeg, Man. (*H*) 609 Ingersoll St. (*S. 1926*) (*A.M. 1931*)

♂BRIGHT, David Mussen, Major, Mgr. and Chief Engr., D. M. Bright & Co., New Bank of Toronto Bldg., London, Ont. (*A.M. 1921*)

BRISTOL, Wesley Malcolm, (Tor. '05), Dist. Mgr., Can. Westinghouse Co., Halifax, N.S. (*H*) 3 Carteret St. (*A.M. 1925*)

BRITTAIN, N. W., B.Sc., (N.B. '32), Private Practice, Minto, N.B. (*S. 1932*)

BRODERICK, C. A., Surveyor and C.E., P.O. Drawer 2186, Trail, B.C. (*H*) Riverside Ave. (*Jr. 1913*)

BRONSON, Frederic E., B.Sc., (McGill '09), Man. Dir., The Bronson Co., 150 Middle St., Ottawa, Ont. (*H*) Rockcliffe Park. (*S. 1908*) (*A.M. 1913*) (*M. 1925*)

BROOKE, John (*g*), Hervey Junction, Que. (*A.M. 1899*) (*Life Member*)

BROOKS, Albert, Sir John Jackson Ltd., 53 Victoria St., Westminster, S.W.1. (*H*) 77 Priory Rd., Kilburn, London, N.W.6. (*M. 1912*)

♂BROOKS, Chas. L., Lieut., B.Sc., (McGill '22), Gen. Traffic Engr., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 4025 Dorchester St. W., Westmount, Que. (*S. 1921*) (*A.M. 1930*)

BROOKS, John Kenneth, 77 Priory Rd., London, N.W.6, England. (*A.M. 1932*)

BROPHY, Geo. Patrick, Asst. Engr., D.P.W., Canada, Customs Bldg., Fort William, Ont. (*A.M. 1921*)

BROUGHTON, Wm. Hamilton, Chief Engr., Power Plant at Absorption Plant 2, Royalite Oil Co. Ltd., Turner Valley, Alta. (*H*) 825-5th Ave. N.W., Calgary, Alta. (*A.M. 1926*)

BROWN, Alan C., B.Sc., (Man. '34), P./O., R.A.F., No. 2 Flying Training School, Digby, Lincs., England. (*S. 1933*)

♂BROWN, Chas. Kenneth, Capt., M.C., Address unknown. (*S. 1907*) (*A.M. 1920*)

BROWN, Collingwood B., Jr., C.E., (Cornell), Chief Engr., Oper. Dept., C.N.R., Rm. 408, 360 McGill St., Montreal, Que. (*H*) 152 Easton Ave., Montreal West, Que. (*S. 1902*) (*A.M. 1909*) (*M. 1914*) (*Member of Council, E.I.C.*)

G.†BROWN, Ernest, M.Sc., M.Eng., Dean of the Faculty of Engrg., McGill University, Montreal, Que. (*H*) 4035 Harvard Ave. (*A.M. 1906*) (*M. 1917*)

BROWN, Ernest F., B.Eng., (McGill '35), Northern Foundry and Machine Co., Sault Ste. Marie, Ont. (*S. 1935*)

BROWN, F. Gordon, 23 Highfield St., Moncton, N.B. (*S. 1924*)

BROWN, George Laing, (Tor. '93), Town Engr., Morrisburg, Ont. (*A.M. 1907*) (*Life Member*)

♂BROWN, George Sandles, Canal Supt., D.N.R., C.P.R., Private Box 123, 207-7th St. S., Lethbridge, Alta. (*Jr. 1921*) (*A.M. 1921*)

BROWN, Harry Cleophas, B.Sc., (McGill '17), Hotel Huntington, Huntington, W.Va. (*A.M. 1925*)

♂BROWN, Hilton Orland, Lieut., B.A.Sc., (Tor. '12), Asst. Plant Engr., Abitibi Power and Paper Co., Sault Ste. Marie, Ont. (*H*) 220 Pim St. (*A.M. 1929*) (*Sec.-Treas., Sault Ste. Marie Br., E.I.C.*)

BROWN, John Elliott, Gen. Mgr., Ottawa Hydro-Elec. Comm., Ottawa, Ont. (*H*) 149 Carling Ave. (*M. 1918*)

BROWN, LeRoy, B.A.Sc., (Tor. '15), Pres. and Mgr., L. R. Brown & Co. Ltd., Engrs. and Contrs., Sault Ste. Marie, Ont. (*H*) 52 The Drive. (*S. 1914*) (*A.M. 1917*)

BROWN, Philip Piggott, Cons. Engr., 510 Royal Trust Bldg., 626 Pender St., Vancouver, B.C. (*A.M. 1913*) (*M. 1919*)

BROWN, R. C. C., B.Sc., (Queen's '33), 699 Acacia Ave., Rockcliffe, Ottawa, Ont. (*S. 1933*)

BROWN, Thos. W., B.A.Sc., (Tor. '10), D.L.S., A.L.S., S.L.S., Dist. Surveyor, D.P.W. Alta., Edmonton, Alta. (*H*) 10139-112th St. (*S. 1907*) (*A.M. 1913*)

BROWN, Wm. Boughton, B.Sc., (N.S.T.C. '31), Can. Gen. Elec. Co. Ltd., 489 King St., Peterborough, Ont. (*H*) Clark's Harbour, N.S. (*S. 1931*)

BROWN, Wm. Edward, B.A.Sc., (Tor. '32), The B. Greening Wire Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. (*Jr. 1934*)

♂BROWNE, Ernest Frank, Lieut., B.Sc., (Queen's '14), D.L.S., Surveys Engr., Topographic and Aerial Surveys Bureau, Dept. Interior, Ottawa, Ont. (*H*) 249 First Ave. (*S. 1911*) (*Jr. 1918*) (*A.M. 1920*)

♂BROWNE, Geo. Alleyn, Major, Asst. Gen. Supt., Engrg. Divn., Dept. Pensions and National Health, Ottawa, Ont. (*H*) 389 Daly Ave. (*S. 1908*) (*A.M. 1920*)

BROWNELL, Harold Ross, B.Sc., (McGill '29), Sales Service Engr., Bailey Meter Co. Ltd., 980 St. Antoine St., Montreal, Que. (*H*) 406-1510 Bathurst St., Toronto 10, Ont. (*S. 1927*) (*Jr. 1932*)

BROWNIE, F. Austin, B.Sc., (Alta. '34), Inspr. of Assessments, Dept. of Municipal Affairs, Alta., Edmonton, Alta. (*H*) 514-9th Ave. N.E., Calgary, Alta. (*S. 1932*)

BRUCE, Chas., Chief Fisheries Engr., Dept. of Fisheries, Hunter Bldg., Ottawa, Ont. (*H*) 35 Ossington Ave. (*S. 1907*) (*A.M. 1919*)

BRUCE, Wm. Jos., C.E., (Tor. '07), R.C.A.F., Project No. 28, Trenton, Ont. (*A.M. 1926*)

BRUMBY, Walter Wm., Can. Gen. Elec. Co. Ltd., 1065 W. Pender St., Vancouver, B.C. (*H*) 1408-45th Ave. W. (*Jr. 1930*) (*A.M. 1932*)

BRUMELL, John H., Box 1223, Kirkland Lake, Ont. (*S. 1920*) (*Jr. 1930*)

BRUMELL, Orby R., B.Eng., (McGill '34), Dom. Rubber Co. Ltd., Montreal, Que. (*H*) 902 Burnside Place. (*S. 1930*)

♂BRUNNER, Godfrey H., Major, M.Sc., (McGill), Engr., Imperial Chemical Industries, United Alkali Co. Ltd., Fleetwood, Lancs, England. (*H*) Hazeldene, Poulton-le-Fylde, Lancs. (*S. 1904*) (*A.M. 1911*)

BRYANT, Jas. S., B.Sc., (McGill '27), Drummondville, Que. (*S. 1925*) (*Jr. 1930*)

♂BRYCE, William F. McK., Lieut., (Tor. '08), Sewer Engr., City of Ottawa, City Hall, Ottawa, Ont. (*H*) 120 Buena Vista Rd., Rockcliffe Park. (*S. 1909*) (*A.M. 1913*)

BRYDON, Noel Morris, B.Sc., (St. Andrews '22), Pres. and Gen. Mgr., Brydon Construction Co. Ltd., 182 Dunvegan Rd., Toronto, Ont. (*A.M. 1932*)

♂BRYDONE-JACK, H. D., Capt., M.C., B.Sc., (McGill '11), C.P.R., Virden, Man. (*A.M. 1924*)

BUBBIS, Nathan S., B.Sc., (Man. '34), City Engrs. Office, Winnipeg, Man. (*H*) 406 Andrews St. (*S. 1934*)

♂BUCHAN, P. H., Lieut., B.A.Sc., (Tor. '09), Asst. Engr., Mtce. of Way, B.C. Electric Rly. Co., Ltd., Vancouver, B.C. (*H*) 1984-41st Ave. West. (*A.M. 1919*) (*M. 1935*)

BUCHANAN, Colin Archibald, B.Sc., (McGill '19), Chief Engr., Donnacona Paper Co. Ltd., Donnacona, Que. (*H*) Portneuf, Que. (*A.M. 1919*)

BUCHANAN, Edward Trevor, B.Sc., (McGill '28), 2327 Clifton Ave., Montreal, Que. (*S. 1926*)

BUCHANAN, Edward Victor, (A.R.T.C., (Glasgow), Gen. Mgr., Public Utilities Comm., London, Ont. (*H*) 776 Wellington St. (*M. 1922*)

BUCHANAN, Walter S., Elec. Contr., 407 St. Cyrille St., Quebec, Que. (*A.M. 1930*)

BUCHMANN, Karl E., B.A.Sc., (Tor. '25), Designing Dftsman., Falconbridge Nickel Mines Ltd., Falconbridge, Ont. (*S. 1922*) (*Jr. 1926*) (*A.M. 1930*)

BUCK, Harold W., Ph.B., (Yale '94), E.E., (Columbia '95), Vice-Pres., Viele, Blackwell & Buck, 19 Rector St., New York, N.Y. (*H*) 101 East 72nd St. (*M. 1919*)

BUCK, L. Gordon, B.A.Sc., (Tor. '25), Divn. Plant Engr., M.D., Bell Telephone Co. of Canada, 87 Ontario St. W., Montreal, Que. (*H*) 5567 Dunmore Ave. (*A.M. 1935*)

♂BUCK, Richard S., Major, D.S.O., (Renss. '87), 297 Henry St., Brooklyn, N.Y. (*M. 1903*)

BUCKE, Harold L., (R.M.C., Kingston), Dist. Bldg. Engr., H.E.P.C. of Ont., Niagara Falls, Ont. (*H*) R.R. 1, Niagara-on-the-Lake, Ont. (*S. 1900*) (*A.M. 1904*) (*M. 1912*)

BUCKLEY, I. Walter, Oper. Contr., Dom. Coal Co., Glace Bay, N.S. (*H*) 190 Brookland St., Sydney, N.S. (*A.M. 1921*)

BUCKLEY, Rex. E., Engr. i/c Constrn., New-Kanawha Power Co., P.O. Box 122, Glen Ferris, W.Va. (*A.M. 1919*)

BUDDEN, Arthur N., B.Sc., (McGill '28), Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 1509 MacKay St., Montreal, Que. (*S. 1921*) (*Jr. 1926*) (*A.M. 1930*)

BUELL, Milton Alan, B.Sc., (Queen's '34), 54 Wellington St., Kingston, Ont. (*S. 1933*)

BUERK, Jacob Edward, 700 Taylor St., Vancouver, B.C. (*A.M. 1920*)

BULLER, Francis Hamilton, B.Sc., (McGill '23), M.S., (Union '31), Cable Engr., General Electric Co., 1 River Rd., Schenectady, N.Y. (*H*) 242 Union St. (*S. 1920*) (*A.M. 1931*)

BUNCKE, Harry Jacob, C.E., (Columbia '15), Chief Engr., Oxford Paper Co., Rumford, Maine. (*M. 1928*)

BUNNELL, Arthur E. K., B.A.Sc., (Tor. '07), Partner, Wilson & Bunnell, Cons. Engrs., 388 Yonge St., Toronto, Ont. (*H*) 49 Lawrence Ave. E. (*S. 1907*) (*A.M. 1911*) (*M. 1925*)

BUNTING, Wm. Lloyd, B.Sc., (Man. '28), Municipal Engr., Flin Flon, Man. (*S. 1927*) (*Jr. 1934*)

♂BUNTING, Wm. Russell, B.A.Sc., (Tor. '23), Power Apparatus Specialist, Northern Electric Co. Ltd., 1600 Notre Dame St. W., Montreal, Que. (*H*) 4550 King Edward Ave., N.D.G. (*S. 1920*) (*Jr. 1925*) (*A.M. 1928*)

♂BURBANK, Jerome Douglas, B.A.Sc., (Tor. '25), Elec. Engr., Buffalo, Niagara and Eastern Power Corpn. (Niagara Lockport Divn.), Buffalo, N.Y. Box 506, Central Y.M.C.A., 45 West Mohawk St. (*S. 1921*) (*Jr 1926*) (*A.M. 1931*)

♂BURBIDGE, George Harrison, Lieut., B.A., (Tor.), B.Sc., (McGill '09), Senior Asst. Engr., D.P.W., Box 277, Port Arthur, Ont. (*H*) 28 North Hill St. (*S. 1908*) (*A.M. 1912*) (*M. 1919*) (*Member of Council, E.I.C.*)

†BURCHELL, Herbert C., Pres., Eastern Lime Co., Windsor, N.S. (*M. 1887*) (*Life Member*)

♂BURCHILL, Geo. Herbert, B.Sc., (N.S.T.C. '23), Asst. Prof. of Elec. Engrg., N.S. Technical College, Halifax, N.S. (*H*) 202 Jubilee Rd. (*S. 1923*) (*Jr. 1926*) (*A.M. 1931*)

BURDETT, Geo. H., B.Sc., (Ecole Polytech., Montreal '27), Traffic Engr., The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 3801 Botrel Ave. (*S. 1926*)

BURGAR, Frederick A., C.E., (Renss. '13), Box 200, Campbellford, Ont. (*A.M. 1920*)

♂BURGESS, Bert I., B.Sc., (N.B. '21), Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 595 King St. (*Jr. 1924*)

BURGESS, George Heckman, B.Sc., (Wis.), Partner, Coverdale & Colpitts, 120 Wall St., New York, N.Y. (*H*) 51 Fifth Ave. (*M. 1912*)

BURGESS, James Roy, B.A.Sc., (Tor. '10), Mech. Supt., Staunton's Ltd., 944 Yonge St., Toronto, Ont. (*H*) 328 Forman Ave. (*A.M. 1921*)

BURKE, E. V., 38 Bonaventure Ave., St. John's, Nfld. (*S. 1935*)

BURKE, John A., B.Sc., (Alta. '34), 628-15th St. S., Lethbridge, Alta. (*S. 1934*)

BURKE, John William, Cons. Engr., 1 Wall St., New York, N.Y. (*H*) 112 Hill Crest Ave., Yonkers, N.Y. (*M. 1903*)

BURKET, Leslie Howard, Str'l. Engr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 165 Bedbrook Ave., Montreal West, Que. (*A.M. 1926*)

BURLEY, J. G., B.Sc., (Queen's '26), 34 Highview Cres., Toronto, Ont. (*S. 1926*)

BURNHAM, D. E., B.Sc., (N.S.T.C. '28), M.Eng., 3485 Hutchison St., Montreal, Que. (*S. 1928*)

BURNS, C. H. McL., Asst. Mgr., Canada Foundries and Forgings, Ltd., Welland, Ont. (*H*) 105 Dorothy St. (*A.M.* 1920)

BURNS, Edward Thompson, B.A.Sc., (Tor. '30), Can. Gen. Elec. Co., 212 King St. W., Toronto, Ont. (*S. 1930*)

♂BURNS, E. L. M., Major, O.B.E., M.C., R.C.E., (R.M.C., Kingston '15), Gen. Staff Officer Surveys, Geographical Section, Dept. National Defence, Ottawa, Ont. (*H*) 41 Findlay Ave. (*Jr. 1920*) (*A.M. 1925*)

BURNS, Robert H., Res. Engr., Abitibi Power and Paper Co. Ltd., Sault Ste. Marie, Ont. (*H*) 525 Albert St. E. (*Jr. 1925*)

BURNS, William, 732 McMillan Ave., Winnipeg, Man. (*A.M. 1890*) (*M. 1902*) (*Life Member*)

BURNSIDE, Robert John, B.A.Sc., (Tor. '27), Madoc, Ont. (*S. 1927*) (*A.M. 1932*)

BURPEE, David Wm., 732 Brunswick St., Fredericton, N.B. (*A.M. 1905*) (*M. 1910*) (*Life Member*)

BURPEE, Frederick D., Vice-Pres. and Mgr., The Ottawa Electric Railway Co., Ottawa, Ont. (*H*) 443 Albert St. (*Affil. 1922*)

BURPEE, Geo. Wm., A.B., S.B., Partner, Coverdale & Colpitts, Cons. Engrs., 120 Wall St., New York, N.Y. (*H*) 39 Woodland Ave., Bronxville, N.Y. (*A.M. 1912*) (*M. 1917*)

BURPEE, Lawrence H., B.A.Sc., (Tor. '25), Beauharnois L.H. & P. Co., Box 50, Beauharnois, Que. (*H*) 22 Rideau Terrace, Ottawa, Ont. (*S. 1924*) (*A.M. 1932*)

BURPEE, Moses, Cons. Engr., Bangor & Aroostook Ry., Box 450, Houlton, Me. (*H*) 90 Court St. (*M. 1890*) (*Life Member*)

BURR, Edmund G., B.Sc., (McGill '07), Cons. Engr., McGill University, Montreal, Que. (*S. 1907*) (*Jr. 1911*) (*A.M. 1912*)

BURRI, Henry Wm., B.Eng., (McGill '35), Warden King Ltd., Montreal, Que. (*H*) 3663 Jeanne Mance. (*S. 1934*)

BURROWS, Acton, Pres., Acton Burrows Ltd., "Canadian Railway and Marine World," 70 Bond St., Toronto 2, Ont. (*H*) 120 Bedford Rd., Toronto 5, Ont. (*Affil. 1906*)

BURY, Bertram Edward, (Liverpool '96), Private Practice, Box 292, Vermilion, Alta. (*A.M. 1922*)

†BUSFIELD, James L., B.Sc., (A.C.G.I.), Man'g. Director, Gardner Engines (Eastern Canada), Ltd., Keefer Bldg., 1440 St. Catherine St. W., Montreal, Que. (*S. 1908*) (*A.M. 1913*) (*M. 1922*) (*Member of Council, E.I.C.*)

♂BUSH, Clayton E., Major, B.A.Sc., (Tor. '07), D.L.S., O.L.S., A.L.S., Private Practice, 73 Fairlawn Ave., Toronto, Ont. (*A.M. 1921*)

♂BUSS, Paul E., Vice-Pres., Spun Rock Wools Ltd., Thorold, Ont., P.O. Box 35. (*H*) 20 Vine St. (*A.M. 1927*)

BUTLER, Ernest W. R., B.Sc., (McGill '24), Western Canada Mgr., Bailey Meter Co., Ltd., 907 McArthur Bldg., Winnipeg Man. (*H*) 207 Waterloo St. (*S. 1924*) (*Jr. 1930*)

BUTLER, H. C., B.Sc., (McGill '30), Asst to Chief Engr., Dom. Rubber Co. Ltd., Montreal, Que. (H) 621 Milton St. (S. 1930) (Jr. 1935)

BUTLER, J. A. T., B.Eng., (McGill '34), St. Lawrence Sugar Refineries Ltd., Montreal East, Que. (H) Apt. 5, 2168 Sherbrooke St. W. (S. 1931)

BUTT, Robert Edwards, Steel Co. of Canada, Hamilton, Ont. (H) 6 Lakeside Ave., Hamilton Beach, Ont. (A.M. 1922)

♂BUTTERWORTH, J. V., B.Sc., (N.S.T.C. '23), Topographical Engr., Bureau of Economic Geology, Ottawa, Ont. (H) 380 First Ave. (S. 1923) (A.M. 1928)

BUZZELL, Henry Walter, B.Sc., (McGill '24), Str'l. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (H) 119-34 Ave., Lachine, Que. (S. 1923) (A.M. 1930)

BYERS, Arch'n F., B.Sc., (McGill '00), Pres., A. F. Byers & Co. Ltd., 1226 University St., Montreal, Que. (H) 5606 Queen Mary Rd., Hampstead, Que. (S. 1899) (A.M. 1906) (M. 1911)

♂BYRNE, John Herbert, Capt., B.Sc., (McGill '09), 8 Renfrew Ave., Ottawa, Ont. (S. 1909) (A.M. 1915)

♂CADE, John Edwin, Capt., Asst. Chief Engr., Fraser Bros. Ltd., Edmundston, N.B. (H) 38-20th Ave. (A.M. 1933)

CADRIN, Paul Emile, St. Anselme, Que. (S. 1935)

CAGEORGE, Nicholas, Chief Drftsman, Str'l. Divn., Dominion Bridge Co. Ltd., Montreal, Que. (H) 80-44th Ave., Lachine, Que. (A.M. 1921)

♂CAIRNS, Harry Lister, Lieut., Engr. i/c. Project 76, Dept. National Defence, Choate, B.C. (H) 2282 York St., Vancouver, B.C. (A.M. 1921)

CALDER, Frank, B.Sc., (McGill '30), Box 136, Arvida, Que. (S. 1929)

♂CALDER, Wm., Capt., c/o Lloyd's Bank, Ltd., 39 Threadneedle St., London, England. (M. 1935)

CALDWELL, Fred. Wm., S.B., (M.I.T. '99), New York State Planning Board, 353 Broadway, Albany, N.Y., and Cons. Engr. (H) 838 Union St., Schenectady, N.Y. (M. 1929)

CALKINS, Harold A., B.Sc., (McGill '12), Asst. to Chief Engr., California Packing Corp., 101 California St., San Francisco, Calif. (H) 5448 Boyd Ave., Oakland, Calif. (Jr. 1913) (A.M. 1924)

CALLAGHAN, John, Gen. Mgr., Alberta and Great Waterways Co., Rm. 303, C.P.R. Bldg., Edmonton, Alta. (M. 1908)

†CALLANDER, Delmer Wallace, B.Sc., (McGill '11), Elec. Engr., Can. Westinghouse Co. Ltd., Hamilton, Ont. (H) 99 Leinster Ave., S. (A.M. 1927)

CALVERT, David Gordon, Strathroy, Ont. (Jr. 1918) (A.M. 1919)

♂CALVIN, Jonathan David, Major, B.A., B.Sc., (Queen's '07), Mgr., Tree Line Navigation Co. Ltd., 1010 Common St., Montreal, Que. (H) 505 Argyle Ave., Westmount, Que. (A.M. 1920)

♂CALVIN, Reginald Marsh, Major, B.A., B.Sc., (Queen's '14), Sales Mgr., Can. Vickers Ltd., Montreal, Que. (H) 315 Oliver Ave., Westmount, Que. (S. 1914) (A.M. 1919)

†CAM, William George Herbert, (A.C.G.I.), Power and Safety Engr., Canada Cement Co. Ltd., Montreal, Que. Box 290, Sta. B. (H) 151 Dobie Ave., Town of Mount Royal, Que. (A.M. 1912) (M. 1929)

CAMERON, Dougald, Vice-Pres., John T. Hepburn Ltd., 18 Van Horne St., Toronto 4, Ont. (H) 40 Crang Ave. (A.M. 1933)

CAMERON, D. Roy, B.A., (McGill '09), B.Sc.F., (Tor. '11), Assoc. Director of Forestry, Forest Service, Dept. Interior, Ottawa, Ont. (H) 173 Daly Ave. (A.M. 1921) (M. 1925)

CAMERON, Evan Guthrie, C.E., (R.M.C. Kingston), Principal Asst. Engr., Welland Ship Canal, Dept. of Rlys. and Canals, St. Catharines, Ont. (H) 169 Ontario St. (S. 1906) (A.M. 1911) (Vice-President, E.I.C.)

CAMERON, Hugh Donald, B.Sc., (McGill '01), Can. Mgr., Locomotive Firebox Co., 803 McGill Bldg., Montreal, Que. (H) 745 Upper Belmont Ave., Westmount, Que. (S. 1899) (A.M. 1913)

CAMERON, Jas. S., B.Sc., (McGill '08), Asst. Gen. Supt., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (H) 4467 Montrose Ave., Westmount, Que. (S. 1906) (A.M. 1912)

CAMERON, John, B.Sc., (N.S.T.C. '27), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (H) 574 Douglas Ave. (S. 1927)

♂CAMERON, Kenneth G., B.Sc., (Edinburgh '12), Chief Engr., Canada and Dominion Sugar Co. Ltd., Montreal, Que. (H) 38 Dufferin Rd., Hampstead, Que. (Jr. 1914) (A.M. 1920)

†CAMERON, Kenneth MacKenzie, (R.M.C., Kingston '01), M.Sc., (McGill '03), Chief Engr., D.P.W., Canada, Ottawa, Ont. (H) 312-1st Ave. (S. 1901) (A.M. 1907) (M. 1920)

CAMERON, Norman Chas., (Tor. '04), Engr., Imperial Tobacco Co. of Canada, 3810 St. Antoine St., Montreal, Que. (H) 466 Mountain Ave., Westmount, Que. (A.M. 1907)

♂CAMERON, Norman Keith, Cameron & Phin, Contractors, P.O. Box 95, Welland, Ont. (A.M. 1922)

♂CAMPBELL, Alex., M.Sc., (McGill '26), Contracting Engr., Dom. Bridge Co. Ltd., 702 Canada Bldg., Winnipeg, Man. (H) 23 Lindbergh Apts. (S. 1922) (A.M. 1927)

CAMPBELL, Angus D., B.A.Sc., M.E., (Tor. '11), Safety Engr., McIntyre Porcupine Mines, Ltd., Box 11, Schumacher, Ont. (M. 1918)

CAMPBELL, Duncan Chester, B.Sc., (N.B. '34), 210 Winslow St., West Saint John, N.B. (S. 1935)

♂CAMPBELL, George Wilfred, Asst. Engr., Reclam. Br., P.W.D., 318 Parliament Bldgs., Winnipeg, Man. (H) 200 Vaughan St. (Jr. 1920) (A.M. 1930)

♂CAMPBELL, Harold Montgomery, Lt.-Col.. M.C., B.A.Sc., (Tor. '14), Asst. Engr. (Mech.), Welland Ship Canal, St. Catharines, Ont. (A.M. 1931)

CAMPBELL, James G., 565 Victoria Rd., Walkerville, Ont. (A.M. 1919)

♂CAMPBELL, James M., Lieut., Divn. Engr., C.P.R., Lethbridge, Alta. (H) 1310-5th Ave. S. (A.M. 1920)

CAMPBELL, Jas. S., B.Sc., (Queen's '31), (M.Sc., '33), 119 Logan Ave., Toronto, Ont. (S. 1928)

CAMPBELL, John G. W., C.E., (Ohio Nor.), Res. Engr., Dept. of Highways, N.S., Halifax, N.S. (H) 140 Robie St. (A.M. 1905) (M. 1925)

CAMPBELL, John Murdoch, Pres., Gananoque Electric Light and Water Supply Co. Ltd., Kingston, Ont. (H) 5 Emily St. (M. 1907)

CAMPBELL, Lorne Argyle, Vice-Pres. and Gen. Mgr., West Kootenay Power and Light Co. Ltd., Trail, B.C. (H) Rossland, B.C. (M. 1935)

CAMPBELL, Norman McLeod, B.Sc., Pres., Engineering Equipment Co. Ltd., 420 New Birks Bldg., Montreal, Que. (S. 1899) (A.M. 1911)

♂CAMPBELL, Robert A., E.E., (Tor. '09), Supt., Great Lakes Power Co. Ltd., Sault Ste. Marie, Ont. (A.M. 1923)

CAMPBELL, T. Lorne, B.A.Sc., (Tor. '23), Toronto Hydro-Electric System, Toronto, Ont. (H) 110 Lawrence Ave. W. (S. 1920) (Jr. 1929)

CAMPBELL, Vincent Henry, Dist. Engr., Reclam. Branch, D.P.W., Man., Winnipeg, Man. (H) 683 Strathcona St. (A.M. 1920)

CAMPBELL, Wilfred J., B.A.Sc., (Tor. '25), Relay Engr., Detroit Edison Co., Detroit, Mich. (H) 4715 Maryland Ave. (S. 1925) (A.M. 1931)

CAMPION, William, Designing Engr., Lightning Fastener Co., St. Catharines, Ont. (H) 62 Yates St. (A.M. 1922)

CAMSELL, Charles, C.M.G., LL.D., B.Sc., Deputy Minister, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont. (H) 240 Mariposa Ave., Rockcliffe. (M. 1923) (Past-President)

CANDLISH, John Boyd, 170 Rankin Blvd., Sandwich, Ont. (A.M. 1921)

CANN, Wm. N., Gleeson Martin Ltd., Imperial Bank Bldg., North Bay, Ont. (H) P.O. Box 342, Lennoxville, Que. (A.M. 1910)

CANNIFF, S. W., Asst. Gen. Mgr., Ottawa Hydro-Electric Power Comm., Ottawa, Ont. (H) 66 Ossington Ave. (A.M. 1922)

CANTWELL, Herbert H., B.E., (Union, Tenn. '07), Indust. Engr., C.P. Telegraph Bldg., Montreal, Que. (H) 289 St. Joseph Blvd. W. (A.M. 1921)

♂†CAPE, E. G. M., Col., D.S.O., B.A.Sc., (McGill '98), Pres., E. G. M. Cape & Co., 960 New Birks Bldg., Montreal, Que. (H) 1210 Redpath Crescent. (S. 1899) (A.M. 1902) (M. 1909)

CAPE, John Meredith, (R.M.C., Kingston '32), Engr., E. G. M. Cape & Co., 960 New Birks Bldg., Montreal Que. (H) 1210 Redpath Crescent. (Jr. 1934)

CAPELLE, Wm. A., B.Sc., (Man. '32), Dftsman., T. Eaton Co. Ltd., Winnipeg, Man. (H) 79 Cobourg Ave. (S. 1929)

CAREFOOT, H. R., B.Sc., (Sask. '29), c/o Dept. of Aero. Engrg., Royal College of Science, Exhibition Rd., London, S.W.7, England. (S. 1929)

CAREY, Cyril Jos., Private Practice, P.O. Box E-5442, St. John's, Nfld. (H) "Hillside," Long's Hill. (Jr. 1931) (A.M. 1933)

CAREY, Edward George, Sec.-Treas., Blackmore Co. Ltd., 1118 St. Catherine St. W., Montreal, Que. (H) 4353 Harvard Ave. N.D.G. (A.M. 1926)

CARMEL, Jos. Edward, B.Sc., (Ecole Polytech., Montreal), Supt. of Buildings, City of Montreal, City Hall, Montreal, Que. (H) 224 St. Joseph Blvd. East. (M. 1917)

CARMICHAEL, Jas. Irving, 134 Cameron St., Fort William, Ont. (S. 1935)

CARMICHAEL, Ross MacNevin, B.A.Sc., (Tor. '13), Designing Engr., Dr. F. A. Gaby, Cons. Engr., Rm. 608, University Tower, Montreal, Que. (A.M. 1920)

CARNIEL, Carlo Antonio, 832 St. James St., Montreal, Que. (A.M. 1920)

CARNWATH, James, B.Sc., (McGill '11), Mgr., Concrete Pipe Ltd., 198 Riddell St., Woodstock, Ont. (H) 295 Light St. (A.M. 1927)

†CARON, Jos. Georges, Engr. i/c Technical Service, City of Montreal, City Hall, Montreal, Que. (H) 559 Letourneux St. (Jr. 1921) (A.M. 1919)

CARON, Wm. Robert, Elec. Supt., Quebec Harbour Comm., Quebec, Que. (H) 74 Moncton Ave. (A.M. 1932)

CARPENTER, Edward Emery, B.S., (Stanford '98), Cons. Engr., B.C. Electric Rly. Co. Ltd., Vancouver, B.C. (H) 1689-29th Ave. W. (M. 1924)

CARPENTER, Edward Stanley Cameron, B.Sc., (Sask. '29) 198 Leopold Crescent, Regina, Sask. (A.M. 1931)

†CARPENTER, H. S., B.A.Sc., (Tor. '98), D.L.S., O.L.S., S.L.S., Deputy Minister, Dept. of Highways, Sask., Regina, Sask. (H) 198 Leopold Crescent. (A.M. 1904) (M. 1922) (Life Member)

CARPENTER, Robert Burton, Nobel, Ont. (S. 1928)

♂CARR, David Leonard, Capt., M.C., 118 Green Lane, Northwood, Middlesex, England. (A.M. 1926)

♂CARR-HARRIS, G. G. M., Asst. Prof., Royal Military College, Kingston, Ont. (H) 266 Frontenac St. (A.M. 1930)

♂CARRIE, G. Milroy, B.A.Sc., (Tor. '13), Gen. Mgr., Can. Refractories Ltd., 1050 Canada Cement Bldg., Montreal, Que. (H) 795 Upper Lansdowne Ave., Westmount, Que. (M. 1934)

CARRUTHERS, Alex. Lorraine, Bridge Engr., D.P.W., B.C., Parliament Bldgs., Victoria, B.C. (H) 1258 St. Patrick St. (A.M. 1915) (M. 1921)

CARRUTHERS, Clarence D., B.A.Sc., (Tor. '27), Str'l. Engr., Gordon L. Wallace, 68 Glenwood Ave., Toronto, Ont. (H) 253 Castlefield Ave. (S. 1927) (Jr. 1929) (A.M. 1935)

♂CARSON, George Herbert, Jr., Newfoundland Power and Paper Co. Ltd., Corner Brook, Nfld. (Jr. 1921)

CARSON, J. R., B.Sc., (N.S.T.C. '35), Box 206, Pictou, N.S. (S. 1932)

CARSON, M. S., B.Sc., (Sask. '30), 17 Willcock St., Toronto, Ont. (S. 1931)

CARSON, William Harvey, C.E., (R.T.C., Glasgow), Dist. Engr., Ont., Dept. of Marine, Hunter Bldg., Ottawa, Ont. (H) 63 Fentiman Ave. (A.M. 1910) (M. 1918)

CARSWELL, Ernest R., B.A.Sc., Asst. Chief Chemist, Home Oil Distributors Ltd. (Refinery), North Vancouver, B. C. (H) 2812-12th Ave. W., Vancouver, B.C. (S. 1930)

CARSWELL, John Ballantyne, B.Sc., (Glasgow), Man. Dir., Burlington Steel Co. Ltd., Hamilton, Ont. (H) 3 Turner Ave. (Jr. 1912) (A.M. 1915) (M. 1928)

CARTER, Edward Fairbank, C.E., (Renss.), Vice-Pres. and Dir., John S. Metcalf Co. Ltd., 837 West Hastings St., Vancouver, B.C. (H) 1712 Cedar Crescent. (M. 1916)

♂CARTER, Hugh C., M.C., Director, D.P.W., Belize, British Honduras. (A.M. 1920) (M. 1927)

CARTER, John Russell, B.A.Sc., (Tor. '31), c/o Dept. of Northern Development, Blind River, Ont. (S. 1931)

†CARTMEL, William Bell, M.A., (Nebraska '02), Pres., W. B. Cartmel & Son Ltd., Elec. Engrs. and Contrs., 4801 Wellington St., Montreal, Que. (H) 258 Metcalfe Ave., Westmount, Que. (M. 1922)

†CARTWRIGHT, Conway Edw., C.E., 1131 Beach Ave., Vancouver, B.C. (M. 1899) (Life Member)

♂CARTWRIGHT, George Herbert, Lieut., B.Sc., (McGill '22), Engr. of Way, Quebec Rly., Light, Heat & Power Co., Quebec, Que. (H) St. Louis de Courville, Que. (S. 1920) (A.M. 1926)

♂CARTY, Edward G., Capt., B.Sc., (London '08), Dept. of Rlys. and Canals, Ottawa, Ont. (H) 160 Waverly St. (S. 1910) (A.M. 1912)

CARVER, Stanley C., B.A.Sc., (B.C. '29), Asst. Designing Engr., Fleming Bros. Str'l. Engrs., Glasgow, Scotland. Address: c/o Bank of Montreal, 9 Waterloo Place, London, S.W.1. (S. 1927) (A.M. 1935)

CASEY, William, Pres. and Gen. Mgr., Canadian Locomotive Co. Ltd., Kingston, Ont. (H) 213 King St. (M. 1922)

CASGRAIN, Hon. Col. (Senator) Jos. P. B., D.L.S., Q.L.S., 266 St. James St., Montreal, Que. (H) 1916 Dorchester St. W. (A.M. 1895)

♂CASSELS, W. L. L., Capt., B.Sc., (McGill '13), O.L.S., Q.L.S., D.L.S., Farley & Cassels, 18 Rideau St., Ottawa, Ont. (H) 366 Daly Ave. (A.M. 1924)

CASSIDY, John F., Dftsman, Dept. of Highways, Ont., Parliament Bldgs., Toronto, Ont. (H) 24 Madison Ave. (Jr. 1918) (A.M. 1920)

CASTLEDEN, Geoffrey Percy, B.Sc., (Sask. '27), Engr. and Dftsman, Can. Malartic Gold Mines, Ltd., Amos, Que. (A.M. 1934)

♂†CATE, CARROLL LEE, Lieut., B.Sc., (McGill '09), Trotter & Cate, Consulting Engrs., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 4330 Montrose Ave. (*A.M. 1911*)

†CATON, EDWIN V., Mgr., Elec. Utility, Winnipeg Elec. Rly. Co., 1010 Elec. Rly. Chambers, Winnipeg, Man. (*H*) 71 Brock St. (*M. 1917*) (*Vice-President, E.I.C.*)

♂CAVANAGH, A. L., Capt., M.C., B.E.E., (Man. '11), Supt. of Constrn., City of Winnipeg, 223 James St., Man. (*H*) 331 Baltimore Rd. (*S. 1911*) (*A.M. 1919*)

♂CAWTHRA-ELLIOT, H. M., Major-Gen., C.B., C.M.G., Cawthra Lotten, Lakeview, Ont. (*M. 1920*)

G.†CHACE, W. G., B.A.Sc., (Tor. '03), Cons. Engr., 65 Pleasant Blvd., Toronto, Ont. (*A.M. 1907*) (*M. 1912*)

CHADWICK, AUSTIN RALPH, B.A.Sc., (Tor. '24), Pres., Gunite and Waterproofing Ltd.; Mgr., Construction Equipment Co. Ltd., 1200 Benoit St., Montreal, Que. (*H*) 757 Upper Lansdowne Ave., Westmount, Que. (*S. 1921*) (*A.M. 1930*)

CHADWICK, DOUGLAS MOORE, Sales Engr., Can. Bridge Co. Ltd., Rm. 552, New Birks Bldg., Montreal, Que. (*H*) 152 Balfour Rd., Town of Mount Royal, Que. (*A.M. 1912*)

CHADWICK, RICHARD ELLARD CARDEN, (Tor. '06), Pres., The Foundation Co. of Can., Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*A.M. 1913*) (*M. 1921*)

CHALK, HENRY E., B. Eng. (McGill '33), 4951 Western Ave., Westmount, Que. (*S. 1933*)

†CHALLIES, JOHN BOW, C.E., (Tor. '03), Mgr., Water Resources Dept., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 8 Grove Park, Westmount, Que. (*A.M. 1907*) (*M. 1914*) (*Treasurer, E.I.C.*)

♂CHALMERS, GEO. HANNON, Lieut., B.Sc., (Queen's '18), Inst'man., Dept. of Highways, Ont., 15 Queen's Park, Toronto, Ont. (*H*) 615 Millwood Rd. (*S. 1916*) (*Jr. 1919*) (*A.M. 1924*)

CHALMERS, JOHN, O.L.S., (Tor. '94), 4289 Dorchester St. W., Montreal, Que. (*A.M. 1899*) (*M. 1910*)

CHALONER, CHARLES F. X., Supt'g. Engr., Geodetic Levelling, D.P.W., Canada, Rm. 880, Hunter Bldg., Ottawa, Ont. (*H*) 523 King Edward Ave. (*A.M. 1887*) (*Life Member*)

CHAMBERS, ALLISON ROBERT, B.Sc., (McGill '04), Pres., Gen. Mgr., Malagash Salt Co., New Glasgow, N.S.; Cons. Mining Engr. (*M. 1919*)

♂CHAMBERS, E. C. G., Major, M.C., R.C.E., D.E.O., M.D. No. 11, Dept. National Defence, Work Point Barracks, Victoria, B.C. (*A.M. 1924*)

♂CHAMBERS, HUGH D., Lieut., B.Sc., (McGill '14), Pres., G. D. Peters & Co. of Canada Ltd., Rm. 1021, New Birks Bldg., Montreal, Que. (*H*) 4830 Roslyn Ave. (*S. 1914*) (*A.M. 1922*)

CHAMBERS, HAROLD J. A., B.A.Sc., (Tor. '24), (M.A.Sc., '25), Asst. Engr., Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 337 Kildare Rd. (*S. 1920*) (*A.M. 1930*)

CHAMPAGNE, G. A., B.Eng., (McGill '32), 6726 St. Denis St., Montreal, Que. (*S. 1930*)

CHAMPION, C. H., B.Sc., (McGill '23), Can. International Paper Co., Three Rivers, Que. (*H*) 181 Bonaventure St. (*S. 1923*) (*A.M. 1930*)

CHANDLER, EDWARD SAYRE, B.Sc., (N.S.T.C. '31), Prov. Elec'l. Inspr., Box 55., Charlottetown, P.E.I. (*H*) 17 Park Terrace. (*S. 1930*) (*Jr. 1932*) (*A.M. 1935*)

CHANDLER, RALPH B., B.A.Sc., (Tor. '12), Mgr., Public Utilities Comm., Port Arthur, Ont. (*H*) 24 Rupert St. (*A.M. 1917*) (*M. 1923*)

CHAPAIS, CHARLES, B.A., B.A.Sc., (Ecole Polytech., Montreal '04), Sales Mgr., Casavant Bros. Ltd., St. Hyacinthe, Que. (*H*) 81 Laframboise Blvd. (*A.M. 1910*)

CHAPLEAU, J. P., B.Sc., C.E., (Ecole Polytech. Montreal '20), Supt. of Dredging, Beauharnois L. H. & P. Co., P.O. Box 50, Beauharnois, Que. (*Jr. 1921*) (*A.M. 1923*)

CHAPLEAU, SAMUEL J., Engr., D.P.W., Canada, P.O. Box 203, Ottawa, Ont. (*A.M. 1896*) (*M. 1909*) (*Life Member*)

CHAPLIN, CHARLES JOHN, B.Sc., M.Sc., (McGill '08), Officer i/c, Section Timber Mechanics, Forest Products Research Lab., Princes Risborough, Bucks, England. (*H*) "Lanfranc," Haddenham, Bucks, England. (*S. 1904*) (*A.M. 1912*) (*M. 1917*)

CHAPMAN, ALFRED SAUNDERS, City Engr., City Hall, Calgary, Alta. (*H*) 525–13th Ave. W. (*A.M. 1916*)

♂CHAPMAN, EDWARD WILLARD GORDON, S.B., (N.S.T.C. '14), Div. Engr., C.N.R., Box 614, Edmundston, N.B. (*Jr. 1919*) (*A.M. 1925*)

CHAPMAN, WALTER PECK, 30 Howard St., Toronto, Ont. (*A.M. 1889*) (*M. 1903*) (*Life Member*)

♂†CHAPPELL, FRANK, Col., V.D., Public Relations Mgr., General Motors of Canada, Oshawa, Ont. (*H*) 45 Connaught St. (*S. 1908*) (*A.M. 1913*)

CHAPPELL, M. R., Vice-Pres. and Mgr., Chappells, Ltd., 62–80 Brookland St., Sydney, N.S. (*H*) 36 Ankerville St. (*Affil. 1928*)

CHAPPELLE, JOSEPH WALTER SANDS, (Queen's '03), Res. Engr., D.P.W., Alta., Edmonton, Alta. (*A.M. 1921*)

♂CHARLES, JOHN LESLIE, Major, D.S.O., Supervising Engr., Constrn. Dept., C.N.R., Winnipeg, Man. (*H*) 15 Harrow Apts. (*A.M. 1919*)

CHARLESWORTH, L. C., (Tor. '93), D.L.S., O.L.S., A.L.S., Chairman, Irrigation Council, Director of Water Resources, Alberta, Adminstration Bldg., Edmonton, Alta. (*H*) 9930–106th St. (*M. 1918*)

CHARLEWOOD, C. B., (R.M.C., Kingston), B.Sc., (McGill '31), Noranda Mines, Ltd., Box 361, Noranda, Que. (*S. 1931*)

CHARLTON, RICHARD M., Vice-Pres., Leger & Charlton, Ltd., Contrs., 400 Notre Dame St., Lachine, Que. (*A.M. 1905*)

CHARTIER, ALBERT, Private Practice, Water Conditioning and Engrg. Equipment, 8557 Henri Julian St., Montreal, Que. (*A.M. 1920*)

CHAUSSEE, PIERRE MAURICE, Supt., Elec. Dept., City of Montreal, 4050 Park Ave., Montreal, Que. (*H*) 1612 Blvd. Pie IX. (*S. 1919*) (*Jr. 1922*) (*Affil. 1934*)

CHEESEMAN, EDGAR W., 66 Fleming St., St. John's, Nfld. (*S. 1935*)

CHENE, JEAN D., B.A.Sc., (Ecole Polytech., Montreal), C.E. and Chemist, Dept. of Indian Affairs, Rm. 701, Booth Bldg., Ottawa, Ont. (*H*) 163 Notre Dame St., Hull, Que. (*S. 1909*) (*A.M. 1914*)

CHENEVERT, JOS. GEORGES, B.A.Sc. (Ecole Polytech., Montreal '23), Cons. Engr., 1003 Dominion Square Bldg., Montreal, Que. (*H*) 573 Rockland Ave., Outremont, Que. (*M. 1935*)

CHENNELL, ALWYN C. S., B.Eng., (McGill '33), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 5831 Durocher Ave., Outremont, Que. (*S. 1933*)

CHESHIRE, WM. VERNON, B.Sc., (Man. '23), Equipment Service, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4 Waverly Rd., Pointe Claire, Que. (*S. 1919*) (*A.M. 1930*)

CHESNUT, VICTOR STANLEY, B.A.Sc., (Tor. '09), Sr. Engr., Saint John Harbour Comm., Saint John, N.B. (*H*) 10 Paddock St. (*A.M. 1919*)

♂CHEVALIER, PHILIPPE, Capt., B.A.Sc., (Ecole Polytech. Montreal '05), Asst. Engr., Technical Service, City Hall, Montreal, Que. (*H*) 4695 Roslyn Ave., Montreal, Que. (*S. 1907*) (*A.M. 1913*)

CHIPMAN, ROBERT A., B.Sc., (Man. '32), M.Eng., (McGill '33), Demonstrator, McGill University, Montreal, Que. (*H*) 132 Montrose St., Winnipeg, Man. (*S. 1932*)

♂CHISHOLM, A. HAROLD, B.Sc., (McGill '20), Inter. Power and Paper Co., Corner Brook, Nfld. (*S. 1920*) (*A.M. 1926*)

CHISHOLM, DONALD ALEX., B.Sc., (N.S.T.C. '32), Res. Engr., Dept. of Highways, N.S., Brookfield, N.S. (*H*) Ross St., Mulgrave, N.S. (*S. 1930*) (*Jr. 1934*)

CHISHOLM, FREDERICK A., Local Mgr. and Engr., Southern Canada Power Co., Drummondville, Que. (*A.M. 1909*)

♂CHISHOLM, JOS. D., Lieut., B.Sc., (McGill '23), Bepco Canada Ltd., 1050 Mountain St., Montreal, Que. (*S. 1920*) (*Jr. 1925*) (*A.M. 1930*)

CHISHOLM, WM. RONALD, Antigonish, N. S. (*A.M. 1907*) (*Life Member*)

CHOROLSKY, E., B.A.Sc., (Tor. '26) Dftsman., Can. Bridge Co., Walkerville, Ont. (*H*) 693 Lincoln Rd (*S. 1926*)

CHRISTIAN, J. D., R.M.C., Kingston, Ont. (*S. 1936*)

†CHRISTIE, CLARENCE V., M.A., (Dalhousie '02), B.Sc., (McGill '06), Professor, Elec. Engrg., and Chairman Dept. of Elec. Engrg., McGill University, Montreal, Que.; Consulting Engr. (*H*) 87 Holton Ave., Westmount, Que. (*S. 1908*) (*A.M. 1911*) (*M. 1925*)

CHRISTIE, GEO. WM., B.Sc., (N.S.T.C. '24), Asst. Chief Engr., Imperial Oil Ltd., P.O. Box 490, Dartmouth, N.S. (*H*) 101 King St. (*A.M. 1933*)

CHRISTIE, R. LOUIS, B.Eng., (McGill '35), Engr., Can. Kodak Co., Toronto 6, Ont. (*H*) 192 Indian Rd. (*S. 1932*)

CHRISTIE, WM., B.A.Sc., (Tor. '02), D.L.S., S.L.S., Prince Rupert, Sask. (*M. 1922*)

CHUBB, THOMAS ALFORD, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 18 St. George St., Ste. Anne de Bellevue, Que. (*A.M. 1920*)

CIMON, J. M. HECTOR, B.A., B.A.Sc., C.E., Engr., Price Bros. & Co. Ltd., Price House, Quebec, Que. (*H*) 87 Park Ave. (*S. 1912*) (*A.M. 1919*) (*M. 1930*) (*Member of Council, E.I.C.*)

CLARIDGE, RICHARD EARL, Stromberg-Carlson Telephone Mfg. Co., 211 Geary Ave., Toronto, Ont. (*Affil. 1932*)

♂CLARK, ALBERT WM. GARDNER, Lieut., B.Sc., (McGill '10), Man'g. Dir., B.C. Concrete Co. Ltd., Vancouver, B.C. (*H*) 5058 Pine Crescent. (*S. 1908*) (*Jr. 1913*) (*A.M. 1921*)

CLARK, C. GORDON, B.Sc., (N.S.T.C. '30), Asst. Chief Engr., Atlantic Sugar Refineries, Saint John, N.B. (*H*) 31 Leinster St. (*S. 1929*)

†CLARK, FARLEY GRANGER, Cons. Engr., 121 Colin Ave., Toronto, Ont. (*M. 1916*)

CLARK, GEO., Dftsman., C.N.R., 460 Union Sta., Winnipeg, Man. (*H*) 137 Eugenie St., Norwood Grove. (*A.M. 1934*)

CLARK, GEO. SILAS, B.Sc., (McGill '22), Chief Engr., Molsons Brewery Ltd., 1670 Notre Dame St. E., Montreal, Que. (*H*) 1753 North Ave., Outremont, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1931*)

♂CLARK, HAROLD S., Lieut., B.A.Sc., (Tor. '11), Asst. Engr., Dept. Rlys. and Canals, Welland Ship Canal, St. Catharines, Ont. (*H*) 24 Park Place. (*A.M. 1921*)

CLARK, JAS. E., B.Sc., (Queen's '28), Field Engr., Bell Telephone Co. of Canada, Kingston, Ont. (*H*) 24 Sydenham St. (*S. 1928*) (*Jr. 1932*)

CLARKE, BRUCE PORTEOUS, B.Eng., (McGill '34), Lennoxville, Que. (*S. 1934*)

CLARKE, ERNEST R., B.A.Sc., Engrg. Contr., 278 Douglas Drive, Toronto, Ont. (*A.M. 1906*)

CLARKE, GEORGE C., Vice-Pres. and Treas., Fraser, Brace Engineering Co. Ltd., 107 Craig St. W., Montreal, Que. (*H*) The Chateau, 1321 Sherbrooke St. W. (*M. 1914*)

♂CLARKE, GEO. GOOD, B.Eng., (Liverpool '12), Str'l. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 62 Strathearn Ave., Montreal West, Que. (*A.M. 1925*)

CLARKE, GEO. F., B.Sc., (McGill '31), M.Eng., '35, Prod. Engr., Can. Safety Fuse Co., Brownsburg, Que. (*H*) 3647 University St., Montreal, Que (*S. 1929*)

CLARKE, G. T., B.Sc., (N.S.T.C. '29), Prof. of Engrg., St. Francois Xavier College, Box 183, Antigonish, N.S. (*Jr. 1930*)

†CLARKE, JOHN LEONARD, B.Sc., (London '09), Transm. and Foreign Relations Engr., The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 84–44th Ave., Lachine, Que. (*A.M. 1922*) (*M. 1932*)

CLARKE, O. M., B.Sc., (McGill '31), Worthy Park, Ewarton, Jamaica, B.W.I. (*S. 1929*)

CLARKE, ROSS EUGENE, B.Sc., (Queen's '35), R.R. 3, Gananoque, Ont. (*S. 1935*)

CLARKE, WILFRED ERNEST, Vice-Pres. and Gen. Mgr., The Sydney Foundry and Machine Wks. Ltd., Sydney, N.S. (*H*) 121 Esplanade. (*M. 1923*)

CLARKE, STEPHEN HERBERT, (Address unknown). (*S. 1933*)

CLAXTON, GEORGE, Designing Engr., J. R. Booth & Co. Ltd., Ottawa, Ont. (*H*) 14 Fairbairn Ave. (*A.M. 1919*)

CLEATON, R. EWART, 82 Victoria St., London, S.W.1. (*H*) 46 Peter's Court, London, W.2. (*M. 1923*)

CLEMENT, SHELDON BYRNE, M.Sc., (McGill '02), Chief Engr., T. & N.O. Ry., North Bay, Ont. (*H*) 127 Durrill St. (*S. 1889*) (*A.M. 1906*) (*M. 1911*)

♂CLENDENING, CLAIR ADDISON, Vice-Pres., Northern Public Service Corp. Ltd., 307 Power Bldg., Winnipeg, Man. (*A.M. 1920*)

♂CLENDENING, CHESTER SCOTT, Res. Engr., Lethbridge Northern Irrigation Dist., Diamond City, Alta. (*A.M. 1922*) (*Member of Council, E.I.C.*)

†CLEVELAND, ERNEST A., Chief Commr., Greater Vancouver Water Dist., Chairman, Vancouver and Districts Joint Sewerage and Drainage Bd., Bekins Bldg., Vancouver, B.C. (*H*) 3737 Pine Crescent. (*M. 1914*)

♂CLEVELAND, H. ROLAND, Major, B.A., B.Sc., (McGill '24), Wire and Cable Sales Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 1438 MacKay St. (*S. 1923*) (*Jr. 1928*) (*A.M. 1932*)

CLIMO, PERCY LLOYD, B.Sc., (Queen's '32), Hollinger Cons. Gold Mines, Box 1769, Timmins, Ont. (*S. 1928*) (*Jr. 1934*)

CLINE, CARL GORDON, B.A.Sc., (Tor. '11), (C.E., '22), Sr. Asst. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Inter., Rm. 5, Ontario Power Plant, Niagara Falls, Ont. (*H*) 1784 Dorchester Rd. (*S. 1911*) (*Jr. 1912*) (*A.M. 1914*)

CLUFF, H. D., B.Sc., (Man. '24), Capt., R.C.S., 204 Cordova St., Winnipeg, Man. (*S. 1924*) (*Jr. 1927*)

♂COATES, JAS. PERCY, Capt., Supt'g. Engr., Dept. National Defence, The Armoury, Nelson, B.C. (*A.M. 1926*)

COBBOLD, ROBT. JAS., (A.C.G.I. '29), 7 Shaftesbury Rd., Gillingham, Dorset, England. (*Jr. 1930*)

♂COCHRANE, HEW GRANT, Capt., (R.M.C., Kingston), Pacific Ave., Senneville, Que. (*A.M. 1913*)

COCHRANE, JOHN BRAY, Asst. Dir., Military Surveys, Dept. of National Defence, Ottawa, Ont. (*H*) 10 Dalhousie St. (*M. 1905*)

COCHRANE, M. FARRAR, (Heriot Watt '00), D.L.S., Water Power and Reclam. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Inter., Ottawa, Ont. (*H*) Rockcliffe Park. (*A.M. 1905*) (*M. 1926*)

COCKBURN, JOHN M., B.Sc., (Queen's '24), Telephone Systems Engrg. Dept., Northern Electric Co. Ltd., Montreal, Que. (*H*) 3617 Decarie Blvd. (*S. 1922*) (*Jr. 1927*) (*A.M. 1935*)

♂COCKBURN, J. ROY, B.A.Sc., (Tor. '02), Prof. of Descriptive Geometry, University of Toronto, Toronto, Ont. (*H*) 100 Walmer Rd. (*A.M. 1911*) (*M. 1919*) (*Member of Council, E.I.C.*)

COCKSHUTT, CLARENCE F., B.A.Sc., (Tor. '23), Cons. Mining Engr., 1730 Bank of Commerce Bldg., Toronto, Ont. (*H*) 172 Chatham St., Brantford, Ont. (*S. 1921*) (*A.M. 1928*)

COFFEY, PAUL EDWARD, Montreal Tramways Co., 159 Craig St. W., P.O. Box 444, Montreal, Que. (*S. 1928*)

♂COGDELL, HERBERT, Engr. Lt. Cmdr. (Retired), 2 Dollard St., Montreal South, Que. (*A.M. 1933*)

COKE-HILL, LIONEL, Chief Engr., John S. Metcalf Co. Ltd., 460 St. Helen St., Montreal, Que. (*H*) Apt. 7, 1390 Sherbrooke St. W. (*M. 1922*)

♂COKE, R. NORMAN, Lieut., B.Sc., (McGill '14), Vice Chief Engr. and Gen. Supt., Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*Jr. 1917*) (*A.M. 1923*)

COLE, A. HERMAN, 1550 MacKay St., Montreal, Que. (*S. 1931*)

COLE, FRANCIS THORNTON, B.Sc., (McGill '10), Chief Engr., Eastern Canada Steel Co. Ltd., Quebec, P.Q. (*H*) 211 Brown Ave. (*S. 1908*) (*Jr. 1913*) (*A.M. 1917*) (*M. 1919*)

♂COLE, GEO. E., Lt.-Col., B.Sc., (McGill '06), Director of Mines, Mines Branch, Dept. of Mines and Natural Resources, Law Courts, Winnipeg, Man. (*H*) 774 Wellington Crescent. (*S. 1905*) (*A.M. 1912*)

COLE, GEORGE PERCY, M.Sc., (McGill '06), Technical Engr., Dominion Glass Co., Ltd., Guarantee Bldg., Montreal, Que. (*H*) 4327 Old Orchard Ave. (*M. 1919*)

COLE, L. HEBER, B.Sc., (McGill '06), Mining Engr., Mines Branch, Dept. of Mines, Ottawa, Ont. (*H*) 166 Holmwood Ave. (*M. 1920*)

COLEMAN, SHELDON W., B.Sc., (McGill '28), F./O., R.C.A.F., Dept. National Defence, Ottawa, Ont. (*S. 1925*)

♂COLES, ERIC MORRELL, Capt. D.F.C., B.A.Sc., (B.C. '22), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) Ste 404, 325 James St. S. (*S. 1922*) (*A.M. 1926*)

COLGAN, PATRICK, B.Sc., (N.S.T.C. '34), 47½ Bloomfield St., Halifax, N.S. (*S. 1930*)

COLHOUN, GEORGE A., (Tor. '06), Designing Engr., Hamilton Bridge Co., Hamilton, Ont. (*H*) 84 Dalewood Crescent. (*A.M. 1919*) (*M. 1934*)

COLLE, SAMUEL S., Hydraulic Engr., Beauharnois L., H. and P. Co., Rm. 320, Power Bldg., Montreal, Que. (*H*) Rosemere, Que. (*S. 1919*) (*A.M. 1929*)

COLLET, AIME, C.E., (Ecole Polytech., Montreal '23), Chief Engr., Collet Frères Ltd., 1978 Parthenais St., Montreal, Que. (*H*) 361 Metcalfe Ave., Westmount, Que. (*A.M. 1929*)

♂COLLIER, ERNEST VICTOR, Lt.-Col., D.S.O., Anglo-Persian Oil Co. Ltd., Abadan, Persian Gulf. Address: Bank of Montreal, 47 Threadneedle St., London, England. (*S. 1907*) (*A.M. 1909*) (*M. 1923*)

COLLINS, RICHARD, Asst. Engr., Can. Car and Foundry Co., Montreal, Que. (*H*) 166-44th Ave., Lachine, Que. (*A.M. 1921*)

♂COLLINS, WM. HENRY, B.Sc., (Queen's '20), Sewer Designing Engr., City of Hamilton, Hamilton, Ont. (*H*) 16 Senator Ave. (*Jr. 1920*) (*A.M. 1923*)

♂COLLIS, WILLIE ORME, D.C.M., C. de G., Field Engr., T. & N.O. Rly., Box 205, North Bay, Ont. (*A.M. 1921*)

COLLISON, LLOYD S., B.A.Sc., (Tor. '24), Asst. Waterworks Engr., City of Hamilton. (*H*) 140 Prospect St. N., Hamilton, Ont. (*S. 1921*)

COLLITT, BERNARD, Metallurgist, Jenkins Bros. Ltd., 617 St. Remi St., Montreal, Que. (*H*) 1170 Dorchester St. W. (*M. 1934*)

COLPITTS, GORDON LLOYD, B.Sc., (N.S.T.C. '33), Imperial Oil Ltd., Dartmouth, N.S. (*H*) Imperoyal, N.S. (*Jr. 1934*)

COLPITTS, H. G. M., B.Sc., (N.B. '34), Box 344, Sussex, N.B. (*S. 1934*)

†COLPITTS, WALTER WM., LL.D., M.Sc., (McGill '99), Coverdale & Colpitts, Cons. Engrs., 120 Wall St., New York, N.Y. (*H*) 75 Cleveland Lane, Princeton, N.J. (*S. 1897*) (*A.M. 1899*) (*M. 1905*)

COLTER, ASHLEY A., B.Sc., (McGill '10), Contractor, Box 847, Fredericton, N.B. (*S. 1909*) (*A.M. 1913*)

†COMBE, FRANK AUBREY, Cons. Combustion and Steam Engr., 1188 Phillips Place, Montreal, Que. (*H*) 1770 Queen Mary Rd., Hampstead, Que. (*A.M. 1911*) (*M. 1920*)

COMEAU, JULES, C.E., (Ecole Polytech., Montreal '19), Asst. Engr. i/c Lines and Levels, City of Montreal, City Hall, Montreal, Que. (*H*) 5412 Brodeur Ave., N.D.G. (*S. 1918*) (*Jr. 1921*) (*A.M. 1931*)

CONDON, FREDERICK OXLEY, Office Engr., C.N.R., Moncton, N.B. (*H*) 81 Park St. (*M. 1922*)

CONN, H. G., B.Sc., (Queen's '31), Proctor & Gamble Co. Ltd., Hamilton, Ont. (*H*) 41 Carrick Ave. (*S. 1931*)

CONNELL, CHARLES, Tech. Instructor, C.N.R., Toronto, Ont. (*H*) 14 Spruce St., Oakville, Ont. (*A.M. 1924*)

CONNELL, CHAS. H. N., Dist. Engr., C.N.R., Transportation Bldg., North Bay, Ont. (*H*) 349 Main St. W. (*A.M. 1915*) (*M. 1931*)

CONNELL, THOS. C., Constrn. Accountant, Power Corp. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 278 Oak Ave., St. Lambert, Que. (*A.M. 1917*)

CONNELLY, ALAN B., B.Eng., (McGill '33), R.C.E., Fort Osborne Barracks, Winnipeg, Man. (*S. 1932*)

CONNOR, ARTHUR WILLIAM, B.A., C.E., (Tor. '00), A. W. Connor & Co., Cons. Engrs., 301 Metropolitan Bldg., Toronto, Ont. (*H*) 106 Highland Ave. (*A.M. 1899*) (*M. 1922*) (*Life Member*)

CONWAY, GEORGE R. G., Pres., Mexican Light and Power Co. Ltd., Gante 20, Mexico, D.F. P.O. Box Apartado 490. (*M. 1909*)

COOK, ARCHIBALD S., Asst. to Chief Engr., C.N. Telegraphs, 347 Bay St., Toronto, Ont. (*H*) Lakeview Ave., Clarkson, Ont. (*S. 1902*) (*A.M. 1906*) (*M. 1912*)

COOK, WALTER S. D., (Address unknown). (*M. 1923*)

COOKE, NORMAN LOGAN, B.Sc., (N.S.T.C. '22), Principal, Cunard St. School (Indust. Arts), Halifax Bd. School Commrs., Halifax, N.S. (*H*) 13 Sherwood St. (*A.M. 1930*)

♂COOKE, NORMAN MELVILLE, Capt., B.Sc., (Queen's), Mgr., Tarvia Dept., The Barrett Co. Ltd., Toronto 8, Ont. (*Jr. 1921*) (*A.M. 1930*)

COOKE, W. G., B.Sc., (Dalhousie '27), B.Sc., (N.S.T.C. '30), Berwick, N.S (*S. 1929*)

COOMBES, DAVID EATON, B.Sc., (N.B. '35), North Devon, N.B. (*S. 1935*)

COONEY, R. T., JR., c/o U.S. Bureau of Reclamation, Boulder City, Nevada, U.S.A. (*A.M. 1931*)

COOPER, ASHTON B., B.S., in E.E., (Tufts '03), Gen. Mgr., Ferranti Electric Co. Ltd., Mount Dennis, Toronto 9, Ont. (*M. 1921*)

COOPER, CLARENCE E., (Tor. '99), Municipal Engr., Delta Municipality, Municipal Hall, Ladner, B.C. (*S. 1903*) (*A.M. 1907*)

COOPER, FRANK W., Pres., Engineering Materials, Ltd., 1001 Dominion Square Bldg., Montreal, Que. (*A.M. 1907*)

COOPER, L. O., B.Sc., (McGill '30), 181 Worthington Crescent, Sudbury, Ont. (*S. 1928*)

COOPER, PAUL EMERSON, B.Sc., (McGill '23), Plant Engr., Continental Paper and Bag Corp., Rumford, Maine. (*H*) 116 Knox St. (*S. 1920*) (*Jr. 1925*) (*A.M. 1928*)

COOPER, ROSS HERBERT, B.Sc., (Queen's '09), c/o Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*A.M. 1929*)

COOPER, WM. EVERETT, B.Eng., (McGill '35), Duke-Price Power Co., Ltd., Arvida, Que. (*H*) 60 Hall St. E., Moose Jaw, Sask. (*S. 1935*)

COPP, WALTER PERCY, B.Sc., (McGill '08), Prof. of Civil Engrg., Dalhousie University, Halifax, N.S. (*H*) 394 South St. (*S. 1907*) (*A.M. 1913*) (*M. 1925*)

COPPING, BRUCE GRAY, B.Sc., (McGill '26), Mech. Engr., Coca-Cola Co. of Canada, 200 Bellechasse St., Montreal, Que. (*S. 1926*) (*Jr. 1931*)

CORBETT, JAS. I., B.S. and E.M., (Mich. C.M.T.), Assoc. Engr., H.E., War Dept. U.S. Engr. Office, Huntington, W.Va. (*H*) 1021-11th Ave. (*A.M. 1929*)

CORKUM, P. B., B.Sc., (N.S.T.C. '34), 11 Fraser St., Halifax, N.S. (*H*) Feltzen South, N.S. (*S. 1930*)

CORKUM, PERRY DANIEL, B.Sc., (N.S.T.C. '32 and '33), Massey Harris Co., 1229 King St. W., Toronto, Ont. (*H*) Feltzen South, N.S. (*S. 1932*)

CORLESS, CHAS. V., B.Sc., M.Sc., LL.D., (McGill); LL.D., (Queen's), Gen. Consultant, Mining and Metallurgy, Coniston Place, Tillsonburg, Ont. (*S. 1903*) (*M. 1910*)

CORMIER, ERNEST, B.A.Sc., (Ecole Polytech., Montreal '06), Arch't. and Cons. Engr., 2039 Mansfield St., Montreal, Que. (*S. 1904*) (*A.M. 1909*) (*M. 1935*)

CORNEIL, FRED M., B.Sc., (Queen's '23), Sec.-Treas., Sutherland Construction Co., 1440 St. Catherine St. W., Montreal, Que. (*H*) 4043 Melrose Ave. (*S. 1922*) (*Jr. 1925*) (*A.M. 1929*)

CORNER, EDWARD PONSONBY, Br. Mgr. and Repres., Hamilton Gear and Machine Co., 1120 Castle Bldg., Montreal, Que. (*H*) 2187 Marcil Ave., N.D.G. (*A.M. 1934*)

CORNISH, CHAS. R., B.A.Sc., (B.C. '29), 323-26th St. E., N. Vancouver, B.C. (*S. 1928*) (*Jr. 1932*)

♂CORNISH, JOHN HAROLD, Lieut., Asst. Mgr., U.S. Sales Dept., Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*H*) 160 Cottingham Ave. (*A.M. 1915*)

CORNISH, W. E., B.Sc., (Man. '25), M.Sc., (Alta. '33), Asst. Prof., University of Alberta, Edmonton, Alta. (*H*) 11139-91st Ave. (*S. 1926*) (*Jr. 1930*) (*A.M. 1934*)

CORRIVEAU, R. DE B., Capt., B.Sc., (McGill '00), Asst. Chief Engr., D.P.W., Canada, Ottawa, Ont. (*H*) 21 Broadway Ave. (*S. 1898*) (*A.M. 1904*) (*M. 1918*)

♂COSGROVE, JOHN R., Major, D.S.O., M.C., 54 Priory Rd., High Wycombe, Bucks., England. (*A.M. 1910*) (*M. 1917*)

COSSER, WALTER GEOFFREY, B.Sc., (McGill '30), Dftsman., Hollinger Cons. Gold Mines, Timmins, Ont. Address: Box 187, Schumacher, Ont. (*S. 1930*)

♂COSSITT, LAWRENCE SULIS, 2nd Lieut., B.Sc., (McGill '24), R.C.A. Victor Co. Ltd., Montreal, Que. (*H*) 1441 Drummond St. (*S. 1921*) (*Jr. 1926*) (*A.M. 1932*)

COSSITT, MURRAY FREDRIC, Private Practice, South Terrace St., Sydney, N.S. (*Jr. 1920*) (*A.M. 1927*)

COSTIGAN, J. P. M., B.Sc., (McGill '26), Inspr., Assoc. Factory Mutual Fire Insurance Cos., 184 High St., Boston, Mass. (*H*) 40 Lloyd St., Winthrop, Mass., U.S.A. and 494 Grosvenor Ave., Westmount, Que., Canada. (*S. 1925*) (*A.M. 1935*)

†COSTIGAN, JAMES SHEARER, B.A.Sc., (McGill '94), Pres. and Treas., T. Pringle & Son Ltd., Rm. 420, Coristine Bldg., Montreal, Que. (*H*) 494 Grosvenor Ave., Westmount, Que. (*S. 1889*) (*A.M. 1899*) (*M. 1908*)

COTHRAN, FRANK HARRISON, Cons. Engr., 917 Queens Rd., Charlotte, N.C., U.S.A. (*M. 1926*)

COTTON, CHAS., B.Sc., (Queen's '32), 205 Driveway, Ottawa, Ont. (*S. 1928*)

COULTER, HUGH JOHN, B.A.Sc., (Tor. '23), Detroit City Gas Co., 415 Clifford St., Detroit, Mich. (*H*) 46 Elmhurst Ave. (*S. 1921*) (*Jr. 1925*) (*A.M. 1934*)

COULTIS, SAMUEL GEO., Ph.C., (Mich. '09), Field Supt., Royalite Oil Co., Ltd., Turner Valley, Alta. (*M. 1926*)

COURTICE, E. DEAN W., B.A.Sc., (Tor. '14), i/c Drafting Dept., Hamilton Technical Inst., Hamilton, Ont. (*H*) 81 Rosslyn Ave. S. (*A.M. 1919*)

COURTNEY, ALEX. GORDON, B.Sc., (Man. '31), 640 Sherbrooke St., Winnipeg, Man. (*S. 1930*)

COUSINEAU, AIME, B.A.Sc., (Ecole Polytech., Montreal '09), S.B., (M.I.T. and Harvard), Sanitary Engr., Health Dept., City of Montreal, City Hall Annex, Montreal, Que. (*H*) 4090 Old Orchard Ave. (*S. 1908*) (*A.M. 1915*) (*Member of Council, E.I.C.*)

COUSINEAU, LOUIS PHILIPPE, 4603 St. Catherine St. E., Montreal, Que. (*S. 1934*)

COUSINS, EDWARD L., B.A.Sc., C.E., (Tor. '07), Gen. Mgr., The Toronto Harbour Comm., Harbour Commission Bldg., Toronto, Ont. (*H*) 47 Kingsway, Humber Valley. (*S. 1907*) (*A.M. 1909*) (*M. 1923*)

†COUTLEE, C. R., (R.M.C. Kingston), 148 Duplex Ave., Toronto, Ont. (*S. 1888*) (*A.M. 1894*) (*M. 1901*)

♂COUTLEE, W. F., Lieut., Asst. Engr., D.P.W., Rm. 836, Hunter Bldg., Ottawa, Ont. (*H*) 53 Findlay Ave. (*A.M. 1919*)

♂COUTTS, George, Lieut., M.C., B.Sc., (Glasgow '12), Asst. Engr., Dept. Rlys. and Canals, Hudson Bay Terminal, Churchill, Man. (*A.M. 1920*)

COWAN, Elijah, B.A.Sc., (Tor. '23), Lake St. John Power and Paper Co., Dolbeau, Que. (*S. 1921*) (*A.M. 1934*)

♂COWARD, George W., Major, Div'l. Engr., Entre Rios Rlys. Co. Ltd., c/o Depto. Via y Obras, F.C.E.R., Basavilbasco. E.R., Argentina (*A.M. 1910*)

♂COWIE, Alfred Henry, Lt.-Col., M.C., M.Eng., (Liverpool'16), Mgr., Eastern Divn., Dom. Bridge Co. Ltd., P.O. Box 4016, Montreal, Que. (*H*) 420 Lansdowne Ave., Westmount, Que. (*M. 1932*)

COWIE, Frederick Wm., B.A.Sc., (McGill '86), Cons. Engr., Harbour Commissioners, Montreal, Que. (*H*) 3745 The Boulevard, Westmount, Que (*A.M. 1887*) (*M. 1898*) (*Life Member*)

COWIE, Norman Claude, B.A.Sc., (Tor. '21), 15 Hearst St., Sault Ste. Marie, Ont. (*Jr. 1931*)

♂COWLEY, Arthur T. N., Squad.-Leader, B.Sc., (McGill '10), Supt., Air Regulations, Dept. of National Defence, Ottawa, Ont. (*H*) 148 Cooper St. (*S. 1909*) (*Jr. 1913*) (*A.M. 1925*)

♂COWLEY, Francis P. V., Major, (R.M.C. Kingston), Asst. Engr., City of Vancouver, City Hall, Vancouver, B.C. (*H*) 3435-1st Ave. W. (*S. 1907*) (*Jr. 1913*) (*A.M. 1918*)

COX, Archibald, Box 48, Nordegg, Alta. (*A.M. 1926*)

♂COX, Leonard M., Capt., C.E., (Renss.), Route 3, Box 3579, Napa, Calif., U.S.A. (*M. 1926*)

COXWORTH, Thos. Walker, B.Sc., (Man. '26), Asst. Engr., McClintic-Marshall Corp., 400 N. Michigan Ave., Chicago, Ill. (*H*) 7945 Blackstone Ave. (*A.M. 1935*)

CRAIG, Carleton, B.Eng., (McGill '33), Engrg. Bldg., McGill University, Montreal, Que. (*S. 1931*)

♂CRAIG, Henry Clifford, Lt.-Col., V.D., B.Sc., (Queen's '15), Automotive Engr., Federal Govt., Dept. Inter., Trafalgar Bldg., Ottawa, Ont. (*H*) 182-2nd Ave. (*Jr. 1916*) (*A.M. 1917*)

†CRAIG, Hugo B. R., B.Sc., (Queen's '03), Cons Engr., 795 Richmond St., London, Ont. (*S. 1902*) (*A.M. 1905*) (*M. 1910*)

CRAIG, Jas. W., B.Sc., (Sask.. '27) Ceramic Engr., Can. Refractories Ltd., Montreal, Que. Address: Mines Branch, Sussex St., Ottawa, Ont. (*S. 1928*) (*Jr. 1930*)

♂CRAIG, John Cormack, Major, D.S.O., Director of P.W., Georgetown, British Guiana. (*A.M. 1916*) (*M. 1919*)

CRAIG, Shirley Abbott, B.Sc., (McGill '26), Demonstrator, Engrg. Bldg., McGill University, Montreal, Que. (*Jr. 1927*)

CRAIG, Wm. Royce, B.Sc., (Alta. '33), 639-12th St. S., Lethbridge, Alta (*S. 1933*)

CRAIN, Harold F., B.Sc., (Queen's '32), 169 Cameron St., Ottawa, Ont. (*S. 1932*)

CRAM, Haldane Rodger, B.Sc., (McGill '11), Secy., Federal District Comm., Ottawa, Ont. (*H*) 274 Second Ave. (*A.M. 1919*)

CRANSTON, Philip G., B.Sc., (Queen's '29), Engrg. Dept., Bell Telephone Co. of Canada. Beaver Hall Bldg., Montreal, Que. (*S. 1928*)

CRANSWICK, J. E. B., Sales Engr., Can. Westinghouse Co. Ltd., Revillon Bldg., Edmonton, Alta. (*H*) 16 Leamington Apts. (*S. 1928*)

CRASE, Geo. H., B.C.E., (Mich. '15), Br. Mgr., Horton Steel Works Ltd., Rm. 1609, Northern Ontario Bldg., Toronto, Ont. (*H*) 440 Durie St. (*A.M. 1930*)

CRASTER, J. E., B.A.Sc., (B.C. '30), Cons. Mining and Smelting Co., Box 1146, Trail, B.C. (*S. 1930*)

♂CRAWFORD, A. W., Lieut., M.M. and Bar, B.A.Sc., (Tor. '14), Chairman, Minimum Wage Bd., Ont., Parliament Bldgs., Toronto, Ont. (*H*) 153 Glencairn Ave. (*Jr. 1919*) (*A.M. 1927*)

CRAWFORD, J. Jackson, B.A.Sc., (Tor. '22), Asst. to Tech. Dir., Howard Smith Paper Mills Ltd., 749 Guy St., Montreal, Que. (*H*) 5530 Cote St. Luc Rd. (*S. 1921*) (*A.M. 1927*)

CRAWFORD, Jas. Merrill, B.Sc., (McGill '29), (M.Eng., '32), Elec. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 3427 Harvard Ave. (*S. 1928*)

CRAWFORD, Robert Eric, B.Sc., (McGill '22), Sales Dept., Dom. Engineering Co. Ltd., Box 3150, Montreal, Que. (*H*) 228 Percival Ave., Montreal West, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1933*)

♂CRAWLEY, Ed. A., Lieut., B.A., (Acadia '04), Res. Engr., Dept. of Highways, N.S., Truro, N.S. (*H*) 36 Young St. (*Jr. 1911*) (*A.M. 1916*)

CREALOCK, Archie B., B.A.Sc., (Tor. '15), Cons Engr., 1007 Kent Bldg., Toronto, Ont. (*H*) 502 Riverside Drive. (*S. 1914*) (*A.M. 1923*) (*M. 1935*) (*Member of Council, E.I.C.*)

♂CREASOR, John A., Capt., M.C., B.Sc., (McGill '14), Constrn. Supt., Canada Cement Co., Canada Cement Bldg., Montreal, Que. (*H*) 233 Clarks St., Belleville, Ont. (*S. 1914*) (*Jr. 1919*) (*A.M. 1923*)

CREER, A. D., 1984-45th St., Vancouver, B.C. (*A.M. 1911*) (*M. 1914*)

CREGEEN, Kenneth T., B.Sc., (McGill '23), Res. Engr., Sun Life Assurance Co. of Canada, Montreal, Que. (*H*) 1402 Canora Rd., Town of Mount Royal, Que. (*S. 1921*) (*Jr. 1927*) (*A.M. 1933*)

CREIGHTON, Charles Sydney, B.Sc., (N.S.T.C. '13), Res. Engr., Dept. of Highways, Halifax, N.S. (*H*) 4 Dahlia St., Dartmouth, N.S. (*Jr. 1919*) (*A.M. 1924*)

♂CROIL, Geo. Mitchell, A.F.C., Group Capt., Sr. Air Officer, R.C.A.F., Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 200 Lisgar St. (*A.M. 1924*)

♂CROMBIE, Hugh Arthur, Lieut., B.Sc., (McGill '18), Asst. Mgr., Dom. Engineering Co. Ltd., P.O. Box 3150, Montreal, Que. (*H*) 4707 Upper Roslyn Ave. (*Jr. 1921*) (*A.M. 1926*)

CROMBIE, Wm. B., 34 Eastbourne Ave., Toronto, Ont. (*A.M. 1919*)

♂CROOK, Wesley, Instrumentman, D.N.R., C.P.R., Rainier, Alta. (*Jr. 1923*)

CROOKS, C. M., Plant Engr., Maritime Telegraph & Telephone Co. Ltd., Halifax, N.S. (*H*) 15 Oakland Rd. (*A.M. 1920*)

CROOKSHANK, Allan Robertson, B.A.I., Asst. Engr., D.P.W., Canada, Box 1417, Saint John, N.B. (*H*) 77 Duke St. (*S. 1905*) (*A.M. 1910*) (*M. 1915*)

CROPPER, Wm. Chas. McDonald, B.Sc., (McGill '05), Apparatus Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 1251 Gouin Blvd. W. (*M. 1927*)

CROSBY, Irving B., S.M., (M.I.T.), A.M., (Harvard), Cons. Engrg. Geologist, 6 Beacon St., Boston, Mass. (*H*) 12 Prescott St., Cambridge, Mass. (*Affil. 1930*)

♂CROSS, Edgar Algernon, B.Sc., (Birmingham '09), Cons. Engr., 25 Ferndale Ave., Toronto, Ont. (*A.M. 1925*) (*M. 1935*)

♂CROSS, Frederick George, Major, Asst. Supt., Oper. and Mtce., Dept. Nat. Res., C.P.R., Brooks, Alta. (*A.M. 1912*) (*M. 1932*)

CROSS, George E., B.Sc., (McGill '23), Prof., Montreal Technical School, Montreal, Que. (*H*) 434 Clarke Ave., Westmount, Que. (*S. 1921*) (*Jr. 1928*) (*A.M. 1933*)

CROSS, Douglas Henry, B.Eng., (McGill '34), Dom. Engineering Co. Ltd., Lachine, Que. (*H*) Apt. 4, 1483 Atwater Ave., Montreal, Que. (*S. 1934*)

CROSSLAND, C. W., B.Sc., (McGill '31), M.Sc., (M.I.T. '32), Tech. Asst., Hawker Aircraft Ltd., Kingston-on-Thames, England. Address: 33 Claremont Rd., Surbiton, Surrey, England. (*S. 1928*) (*Jr. 1934*)

†CROSSLEY, Thos. Linsey, Consultant, 388 University Ave., Toronto, Ont. (*H*) 28 Lonsdale Rd. (*A.M. 1916*)

CROTHERS, Donald C., 11 Sydenham St., Kingston, Ont. (*S.1935*)

CROUCH, Milton Edwin, C.E., (Tor. '11), O.L.S., D.L.S., Private Practice, 334 King St., Kingston, Ont. (*H*) 35 College St. (*A.M. 1933*)

CROUCH, W. W., B.Sc., (Man. '16), Partner, Carrothers & Crouch, 412-413 B.M.A. Bldg., Kansas City, Mo. (*H*) 7331 Summit. (*S. 1916*) (*Jr. 1920*) (*A.M. 1922*)

CROWE, Fred. Ernest, B.Sc., (N.B. '34), Jeffry, King's Co., N.B. (*S. 1934*)

CROWELL, Seth W., B.A., (Dalhousie '09), N.S.L.S., Asst. Engr., Dept. of Highways, N.S. (*H*) Amherst, N.S. (*Jr. 1912*) (*A.M. 1918*)

CROWLEY, Charles James, 141 Crescent Rd., Toronto, Ont. (*A.M. 1887*) (*M. 1899*) (*Life Member*)

CROWLEY, J. F., Pres., The J. F. Crowley Co., Dundas, Ont. (*Affil. 1929*)

CRUDGE, Harry J., Bldg. Engr., C.N.R., Moncton, N.B. (*H*) 145 Cameron St. (*S. 1904*) (*A.M. 1910*) (*Member of Council, E.I.C.*)

CRUMP, Norris R., B.Sc., (Purdue '29), C.P.R., Moose Jaw, Sask. (*H*) 178 Athabasca St. W. (*S. 1928*) (*Jr. 1931*)

CRUTHERS, Wm. Maurice, B.A.Sc., (Tor. '12), Asst. Swbd. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 561 King St. (*A.M. 1920*)

CRYER, Edward, Engr., Town of Hampstead, 31 Stratford Rd., Hampstead, Que. (*H*) 5161 Queen Mary Rd. (*A.M. 1932*)

♂CRYSDALE, Cecil Rainsford, Major, M.C., 1237 Cardero St., Vancouver, B.C. (*A.M. 1911*) (*M. 1919*)

♂CRYSLER, Roy Alan, Lieut., B.A.Sc., (Tor. '20), Sales Engr., Canada Cement Co. Ltd., 803 Northern Ontario Bldg., Toronto, Ont. (*H*) 94 Snowden Ave. (*Jr. 1921*) (*A.M. 1924*)

CUDWORTH, W. O., Asst. Engr., Mtce. of Way, C.P.R., Montreal, Que. (*H*) 435 Grosvenor Ave. (*A.M. 1920*)

CULLWICK, Ernest Geoffrey, M.A., (Cantab.), Assoc. Prof. of Elec. Engrg., University of B.C., Vancouver, B.C. (*H*) 1828 Western Parkway, Vancouver, B.C. (*Jr. 1926*)

♂CULPEPER, Bernard Armel, B.Sc., in C.E., (McGill '23), Designing Engr., C. D. Howe & Co., Whalen Bldg., Port Arthur, Ont. (*S. 1920*) (*Jr. 1925*) (*A.M. 1929*)

CUMMIFORD, Shirley A., Res. Engr., Dept. of Highways, Stratford, Ont. (*Jr. 1914*) (*A.M. 1917*) (*M. 1923*)

CUMMING, John E., B.Eng., (McGill '32), R.C.S., Elgin Bldg., Ottawa, Ont. (*S. 1931*)

♂CUMMING, Robt. Egerton, Lieut., Executive Secy., Quebec Dist. Protestant Colonization Society, Quebec, Que. (*H*) 70 Rue d'Artigny. (*A.M. 1927*)

CUNHA, Stanley Herbert, B.Sc., (McGill '05), Elec. Engr., Montreal L., H. and P. Cons., Montreal, Que. Address: 2007 Union Ave. (*A.M. 1922*)

♂CUNNINGHAM, Adam, B.Sc., (Edinburgh '23), Mech. Engr., Price Bros. & Co. Ltd., Kenogami, Que. (*H*) 9 Oak St. (*Jr. 1925*) (*A.M. 1927*)

♂CUNNINGHAM, A. Irwin, Capt., B.Sc., (McGill '14), Constrn. Supt., Aluminum Co. of Canada, Arvida, Que. (*H*) Apt. 24, 1 Rosemount Ave., Westmount, Que. (*S. 1914*) (*A.M. 1925*)

CUNNINGHAM, Geo. Allin, B.A.Sc., (Tor. '29), Dist. Mgr., Imperial Oil Ltd., Peterborough, Ont. (*H*) 331 Reid St. (*S. 1927*)

CUNNINGHAM, Harold E., B.Sc., (McGill '31), Dom. Engineering Co. Ltd., P.O. Box 3150, Montreal, Que. (*H*) 455 Elm Ave., Westmount, Que. (*S. 1929*)

♂CUNNINGHAM, John F., M.M., Supt., Testing Lab., Dept. of C.E., University of Manitoba. (*H*) 918 Somerset Ave., Fort Garry, Man. (*Affil. 1928*) (*A.M. 1932*) (*Sec.-Treas., Winnipeg Br., E.I.C.*)

CUNNINGHAM, Leonard, Dept. of Highways, N.S., Halifax, N.S. (*H*) 19 Brenton St. (*A.M. 1923*)

♂CURREY, Allan Robert, B.A., (Queen's '25), Industrial Utilities Ltd., 1165 William St., Montreal, Que. (*Jr. 1927*) (*A.M. 1934*)

CURRIE, Geo. Jas., B.Sc., (N.S.T.C.), Engr., N.S. Light and Power Co. Ltd., Halifax, N.S. (*H*) 840 Robie St. (*S. 1931*)

♂CURRIE, Homer Lindsay, B.Sc., (N.B. '13), Asst. Engr., C.N.R., 315 Insurance Exchange Bldg., Montreal, Que. (*H*) 55 Cornwall Ave., Town of Mount Royal, Que. (*A.M. 1921*)

CURRIE, Victor Robert, B.Sc., (Queen's '23), Asst. Engr., Trent Canal, Dept. of Rlys. and Canals, Peterborough, Ont. (*H*) 26 Benson St. (*S. 1922*) (*Jr. 1925*) (*A.M. 1931*)

♂CURRY, Angus D. M., Engr. Cmdr., R.C.N., Director of Naval Engrg., Dept. of National Defence, Ottawa, Ont. (*H*) Rockcliffe Park. (*M. 1926*)

CURRY, Herbert N., 40 King St., Windsor, N.S. (*S. 1931*)

CURTIS, A. E., Jr., B.Sc., (McGill '28), Asst. Line Supt., Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 37 Eighth St. (*S. 1926*)

♂CUSHING, Arthur Gibb, B.Sc., (McGill '12), A. G. Cushing, Ltd., Builder, 4790 Meridian Ave., Montreal, Que. (*A.M. 1922*)

CYR, Seraphin A., Supt., Eastern Steel Products Ltd., 1335 Delorimier St., Montreal, Que. (*H*) 4395 St. Andre St. (*Jr. 1931*) (*A.M. 1932*)

D'AETH, John Bancroft, B.Sc., (McGill '08), Engr., Fraser, Brace Ltd., Power Bldg., Montreal, Que. (*H*) 4660 Roslyn Ave. (*A.M. 1916*) (*M. 1924*)

DAIGNAULT, Lawrence G., B.Eng., (McGill '34), Sales Engr., Truscon Steel Co. of Canada, Montreal, Que. (*H*) 2067 Church Ave., Verdun, Que. (*S. 1933*)

DALE, John Clapham, B.Sc., (Alta. '32), Northwestern Utilities Ltd., 10124-104th St., Edmonton, Alta. (*S. 1930*)

♂DALE, Wm. P., B.A.Sc., (Tor. '20), Plant Engr., Dale Estate Ltd., Brampton, Ont. (*A.M. 1922*)

♂DALKIN, George Robert, Asst. Chief Engr., Harbour Commrs. of Montreal, Que. (*H*) 2351 Madison Ave., Montreal, Que. (*A.M. 1920*)

♂DALLYN, Frederick Alfred, Capt., B.A.Sc., C.E., (Tor. '13), Cons. Engr., F. A. Dallyn & Co., Toronto, Ont. Address: Whiteside P.O., Ont. (*A.M. 1915*) (*M. 1922*)

DALZELL, Arthur George, City Planning Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 14 DeSavery Crescent. (*A.M. 1911*) (*M. 1921*)

DALZIEL, Norman Pearson, Bank of Montreal, Waterloo Place, London, England. (*A.M. 1906*) (*M. 1918*)

DALZIEL, William, B.Sc., (Queen's '13), Mgr., St. Thomas Bronze Co., St. Thomas, Ont. (*S. 1911*) (*Jr. 1913*) (*A.M. 1919*)

DANCER, Chas. Henry, 371 Assiniboine Ave., Winnipeg, Man. (*M. 1888*) (*Life Member*)

DANN, Norman Leslie, Cable Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 463 Wiseman Ave., Outremont, Que. (*A.M. 1927*)

DANSEREAU, Jean A. L., (R.M.C. Kingston), Dist. Engr., D.P.W., Canada, P.O. Box 129, Station H., Montreal, Que. (*S. 1909*) (*A.M. 1913*)

DARLING, Arthur Balfour, B.Sc., (McGill '24), 1935 St. Luke St., Montreal, Que. (*S. 1922*)

DARLING, Edward, B.Sc., (McGill '94), Pres., Darling Bros. Ltd., 140 Prince St., Montreal, Que. (*H*) 4303 Montrose Ave., Westmount, Que. (*M. 1925*)

DARLING, Ernest Howard, M.E., (Tor. '13), Cons. Engr., 513 Pigott Bldg., Hamilton, Ont. (*H*) 21 Stanley Ave. (*A.M. 1904*) (*M. 1919*)

DARLING, F. S. (*q*), Hampton, N.H., U.S.A. (*M. 1904*) (*Life Member*)

DARLING, T. C., B.Sc., (McGill '27), Sales Engr., Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 4303 Montrose Ave., Westmount, Que. (*S. 1925*)

DARWIN, Bascom Herman, (R.M.C. Kingston '34), B.Sc., (Queen's '35), Lieut., R.C.E., M.D. No. 10, Winnipeg, Man. (*H*) 622 King's Rd. E., Vancouver, B.C. (*S. 1935*)

♂DAUBNEY, Charles Bruce, B.Sc., (McGill '10), Sr. Office Engr., Dept. of Rlys. and Canals, Ottawa, Ont. (*H*) 73 Broadway Ave. (*A.M. 1916*)

DAUBNEY, James Edwin, B.Sc., (McGill '10), Ford Co. of Canada, E. Windsor, Ont. (*H*) 1106 Victoria Ave., Windsor, Ont. (*A.M. 1917*)

DAVENPORT, Ralph F., B.Sc., (N.B. '34), 716 Charlotte St., Fredericton, N.B. (*S. 1934*)

DAVEY, Ronald Eric, B.A.Sc., (Tor. '35), Dufferin Paving Co. Ltd., Kenora, Ont. (*H*) 2465 Gerrard St. E., Toronto, Ont. (*S. 1935*)

DAVIDSON, Arthur C., B.Sc., (Man. '35), 1732–11th St. W., Calgary, Alta. (*S. 1935*)

DAVIDSON, Geo. Ross, (R.M.C. Kingston '35), R.C.A.S.C., Wolseley Barracks, London, Ont. (*S. 1934*)

DAVIDSON, John Knox, B.Sc., (St. Andrew's), Chief Engr., Electric Reduction Co. of Canada, Ltd., Buckingham, Que. (*Jr. 1930*) (*A.M. 1935*)

♂DAVIDSON, Robert Cheves, Lieut., Roadmaster, C.N.R., Smithers, B.C., P.O. Box 142. (*A.M. 1920*)

DAVIDSON, W. M., B.Sc., (Alta. '25), Supt. of Relief Camps, Dept. Nat. Defence, Camp No. 104, Sooke, B.C. (*H*) Weald Rd., Uplands, Victoria, B.C. (*S. 1924*) (*Jr. 1929*)

♂DAVIES, David C. M., Asst. Engr., Bridge Branch, Dept. of Highways, Sask. (*H*) 2250 Garnet St., Regina, Sask. (*Jr. 1920*) (*A.M. 1922*)

DAVIES, Ewart J., B.Sc., (N.S.T.C. '23), Drfting. Instructor, Peterborough Collegiate and Vocational School, Peterborough, Ont. (*H*) 620 George St. (*S. 1923*) (*Jr. 1927*)

DAVIES, George Victor, Mech. Engr., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 647 Windermere Rd. (*A.M. 1918*)

DAVIES, J. Vipond, Pres., Jacobs & Davies Inc., Cons. Engrs., 30 Church St., New York, N.Y. (*H*) 24 Bowne Ave., Flushing, L.I., N.Y. (*M. 1910*)

†DAVIES, Percy Trevor, (C.G.I. '23), Vice-Pres. and Comm. Mgr., Southern Canada Power Co. Ltd., 355 St. James St. W., Montreal, Que. (*H*) 803 Upper Belmont Ave., Westmount, Que. (*M. 1925*)

♂DAVIES, Stanley J., Capt., M.C. and Bar, (A.R.S.M. '21), Cons. Engr., Oban, Sask. (*H*) 1128 Prospect Ave., Calgary, Alta. (*A.M. 1925*)

♂DAVIES, Vernon Russell, Lieut., M.C., B.Sc., M.Sc., (McGill '23), M.C.E., (Man.), D.L.S., Vice-Pres., Vibration Engineering Co., 484 McGill St., Montreal, Que. (*H*) 4834 Sherbrooke St. W. (*Jr. 1921*) (*A.M. 1923*)

DAVIS, Abraham D., B.Sc., (N.B. '34), 42 Spring St., Saint John, N.B. (*S. 1935*)

DAVIS, Clinton Harold, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 5608 St. Urbain St. (*Jr. 1932*)

†DAVIS, Ernest, Chief Engr. and Asst. Comptroller of Water Rights, Water Rights Br., Dept. of Lands, Parliament Bldgs., Victoria, B.C. (*H*) 1070 St. David St. (*M. 1914*)

♂DAVIS, Frank L., Lieut., Foreman, Project 15, Dept. National Defence, Wagaming, Ont. (*H*) 34 Amherst St., Hull, Que. (*A.M. 1924*)

DAVIS, Geo. Roland, B.Sc., (Queen's '27), H.E.P.C. of Ont., Belleville, Ont. (*H*) 190 Foster Ave. (*S. 1927*) (*Jr. 1930*)

DAVIS, George Sanford, Elec. Engr., J. M. Robertson & Co., 1017 Keefer Bldg., Montreal, Que. (*H*) Apt. 25, Lorne Apts., 3660 Lorne Crescent. (*A.M. 1921*) (*M. 1928*)

DAVIS, Ralph Cargill, B.Sc., (Alta. '34), B.A.Sc., (B.C. '35), Etzikom, Alta. (*S. 1934*)

♂DAVIS, Sydney Herbert, B.Sc., (McGill '23), Fish Lake, Bridge River, B.C. (*S. 1921*) (*Jr. 1924*) (*A.M. 1927*)

DAVIS, Wm. Roe, Jr., B.Sc., (Alta. '34), Asst. Engr., Calgary Power Co., Insurance Exchange Bldg., Calgary, Alta. (*H*) 3819–8th St. S.W. (*Jr. 1935*)

♂DAVISON, C. Fraser, B.Sc., (Queen's '26), Supt. of Chemicals, Windsor Works, Can. Industries Ltd., Windsor, Ont. (*H*) 32 Indian Rd., Sandwich, Ont. (*A.M. 1932*) (*Sec.-Treas., Border Cities Br., E.I.C.*)

DAVY, A. C. M., Lt. Cmdr. (E), R.C.N., Engr. Officer, H.M.C.S. "Stadacona," Dept. Nat. Defence, Halifax, N.S. (*H*) 302 Tower Rd. (*A.M. 1933*)

DAVY, Harold Mortimer, Engr., i/c Test Borings, D.P.W., Rm. 875, Hunter Bldg., Ottawa, Ont. (*S. 1900*) (*A.M. 1906*)

†DAVY, Richard Adams, 26 Sweetland Ave., Ottawa, Ont. (*M. 1887*) (*Life Member*)

DAVY, R. F., 1321 Point St., Victoria, B.C. (*A.M. 1907*)

♂DAWES, A. Sidney, Major, M.C., B.Sc., (McGill '10), Pres. and Mgr. Dir., The Atlas Construction Co., Ltd., 679 Belmont St., Montreal, Que. (*H*) 1725 Cedar Ave. (*A.M. 1914*) (*M. 1921*)

DAWSON, Alex. Scott, B.A.Sc., C.E., (McGill '93), Chief Engr., Dept. of Nat. Res., C.P.R., Calgary, Alta. (*S. 1889*) (*A.M. 1895*) (*M. 1909*) (*Life Member*)

P.†DAWSON, Kenneth Lockhart, B.Sc., (N.S.T.C. '17), Supt., Gas Dept., N.S. Light & Power Co. Ltd., Capitol Theatre Bldg., Halifax, N.S. (*H*) 286 South St. (*Jr. 1919*) (*A.M. 1921*) (*M. 1929*)

DAWSON, Sydney George, B.Sc., (Queen's '12), Sr. Asst. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) Apt. 3, 192 Maclaren St. (*Jr. 1913*) (*A.M. 1918*)

DAWSON, Wm. A., B.Sc., (Queen's '23), Chief of Mech. Design, Ford Motor Co. of Canada, East Windsor, Ont. (*H*) 689 Victoria Rd., Walkerville, Ont. (*S. 1921*) (*A.M. 1925*)

†DAWSON, Wm. Bell, M.A., M.Sc., D.Sc., 7 Grove Park, Westmount, Que. (*M. 1887*) (*Life Member*)

DAY, J. Charles, B.Sc., (McGill '14), P.O. Box C-16, Westboro, Ont. (*S. 1914*) (*A.M. 1920*) (*M. 1928*)

DEAN, Clayton D., B.A.Sc., (Tor. '11), Vice-Pres. and Mgr., Imperial Pipe Line Co. Ltd., Rm. 615, 56 Church St., Toronto, Ont. (*H*) 1 Indian Valley Crescent. (*A.M. 1919*)

DEANS, Chas. W., B.A.Sc., (B.C. '30), M.Sc., (Iowa State '33), Asst. Designer and Estimator, Western Bridge Co. Ltd., Vancouver, B.C. (*S. 1928*)

DeBLOIS, H. C., Isle Bizard, Que. (*S. 1934*)

deBRUNO-AUSTIN, R., Man. Dir. and Chief Engr., Turbine Equipment Co. Ltd., 73 King St. W., Toronto, Ont. (*H*) 7 Rosedale Rd. (*A.M. 1922*)

†deCARTERET, S. Laurence, Ph.B., (C.E.), (Yale '08), Gen. Mgr., Brompton Pulp and Paper Co. Ltd., East Angus, Que. (*A.M. 1919*) (*M. 1926*)

DECARY, Albert R., D.A.Sc., (*q*), Supt'g. Engr., Province of Quebec, P.W., Canada, Quebec, P.Q. (*A.M. 1900*) (*M. 1907*) (*Past President*)

DeCEW, Judson Albert, B.A.Sc., (Tor. '01), Process Engineers, Inc., 9 Prospect Ave., Mt. Vernon, N.Y. (*H*) 290 Claremont Ave. (*A.M. 1906*) (*M. 1919*)

deCHAZAL, Philippe, B.Sc., (McGill '31), c/o Henry Birks & Sons Ltd., Phillips Sq., Montreal, Que. (*Jr. 1930*)

DECHENE, Theo. Miville, B.Sc., (Ecole Polytech., Montreal '27), Asst. Bridge Engr., D.P.W., Quebec, Que. (*H*) 96 Bougainville Ave. (*S. 1922*) (*A.M. 1927*)

DECHMAN, W. F., B.Sc., (N.S.T.C. '29), 131 Catherine St., Sydney, N.S. (*S. 1929*) (*A.M. 1934*)

deHART, Jos. B., M.Sc., (McGill '12), Dist. Inspr. of Mines, Alta., Public Works Bldg., Lethbridge, Alta. (*H*) 1261–4th Ave. S. (*A.M. 1925*) (*M. 1926*)

DELANEY, Wm. Victor, 122 Maple St., Black River, N.Y. (*S. 1921*) (*Jr. 1929*)

♂DELAUTE Frederick J., Major, O.B.E., c/o Mr. F. A. Delaute, 6030 St. Hubert St., Montreal, Que. (*A.M. 1908*)

DELGADO, P. G., City Engr., City of Westmount, City Hall, Westmount, Que. (*H*) 2294 Hingston Ave., Montreal, Que. (*A.M. 1930*)

DELISLE, J. L., B.A.Sc., (Tor. '16), Lavoie & Delisle, Racine St., Chicoutimi, Que. (*H*) 33½ Begin Ave. (*A.M. 1924*)

DEMBITZKY, Thos., 206 Royce Ave., Toronto, Ont. (*S. 1934*)

deMIFFONIS, Henri, B.A., B.Sc., Acting Chief Engr., Dept. of Marine, Ottawa, Ont. (*H*) Kingsmere, Que. (*M. 1935*)

De MOCKO, Gerald Geo., B.Sc., (Queen's '35), 134 Heron St., Fort William Ont. (*S. 1934*)

DEMPSEY, Wesley Thos., B.Sc., (Sask. '34), Camp Dundurn, Dundurn, Sask. (*A.M. 1934*)

DENIS, Leopold Germain, B.Sc., (McGill '99), Dist. Chief Engr., Dom. Water Power and Hydrometric Bureau, Dept. of Interior, 961 Inspector St., Montreal, Que. (*H*) 4231 Wilson Ave. (*M. 1919*)

DENIS, Louis Valmore, B.A.Sc., (Ecole Polytech., Montreal '01), Sr. Asst., D.P.W., Canada, Postal Station B., Box 273, Montreal, Que. (*H*) 2005 Mansfield St. (*S. 1899*) (*A.M. 1909*)

♂DENLEY, William Edward, Lieut., M.C., Dist. Engr., Dept. of Highways, Sask., Box 83, Carlyle, Sask. (*A.M. 1921*)

DENNIS, J. S., Col. C.M.G., 1618 Rockland Ave., Victoria, B.C. (*M. 1901*) (*Past President*) (*Life Member*)

DENNIS, Wm. Melbern, B.Sc., (McGill '09), D.L.S., Geodetic Survey of Canada, Ottawa, Ont. (*H*) 261 Powell Ave. (*A.M. 1920*) (*M. 1923*)

DENNISON, G. H. E., (R.M.C. Kingston '20), Service Engr., Can. Carborundum Co. Ltd., Niagara Falls, Ont. (*H*) 2127 Lundy's Lane. (*Jr. 1926*) (*A.M. 1932*)

DENTON, A. Leslie, B.Sc., (N.B. '32), Lamaque Gold Mines, Ltd., Via Amos, Que. (*S. 1932*)

DePENCIER, Henry P., M.Sc., (McGill), Gen. Mgr., The Dome Mines Co. Ltd., Box 505, South Porcupine, Ont. (*M. 1911*)

deSAVIGNY, Herbert Jas., Dept. of Highways, Sask., Weyburn, Sask. (*A.M. 1920*)

DESBAILLETS, Charles Jules, Chief Engr., Montreal Water Board, and Elec. and Mech. Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 509 Argyle Ave., Westmount, Que. (*A.M. 1917*) (*M. 1920*)

DESBARATS, George J., C.M.G., B.Sc., P.L.S., 330 Wilbrod St., Ottawa, Ont. (*M. 1897*)

♂DESBARATS, G. H., Engr. Lieut. Cmdr., R.C.N.V.R., B.Sc., (McGill '22), Station Supt., Paugan Power Plant, Gatineau Power Co., Low, Que. (*S. 1919*) (*Jr. 1926*) (*A.M. 1933*)

DesBRISAY, A. W. Y., B.Sc., (McGill '27), Lieut., R.C.S., c/o Director of Signals, Dept. National Defence, Elgin Bldg., Ottawa, Ont. (*H*) 102 Bagot St., Kingston, Ont. (*S. 1926*) (*Jr. 1931*)

DESCOTEAUX, Paul R., B.A.Sc., (Ecole Polytech., Montreal '34), Town Engr., Rivard's Bldg., P.O. Box 129-149, Rouyn, Que. (*S. 1934*)

DESJARDINS, Olivier, B.A.Sc., C.E., (Ecole Polytech., Montreal '19), Chief Engr., D.P.W., Que., Parliament Bldgs., Quebec, Que. (*H*) 159 Brown Ave. (*S. 1919*) (*A.M. 1922*)

DesLAURIERS, Louis Wilfrid, Asst. Engr., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 8611 De Gaspe St. (*Jr. 1914*) (*A.M. 1922*)

DESMEULES, S. A., Maria, Bonaventure Co., Que. (*S. 1905*) (*A.M. 1909*)

DESSAULLES, Henri, B.A.Sc., (Ecole Polytech., Montreal '03), Q.L.S., Local Agent and Res. Engr., Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 99 Maple Ave. (*S. 1903*) (*A.M. 1909*) (*M. 1930*)

DeSTEIN, Joseph N., C.E., Cons. Engr., 1704 Scarth St., Regina, Sask. (*H*) 2123 Retallack St. (*S. 1905*) (*A.M. 1909*) (*M. 1915*)

DEWEY, Philip Andrew, B.S., C.E., (Vermont '09), Engr., Can. Ramapo Iron Works, Ltd., Niagara Falls, Ont. (*H*) 1224 Ontario Ave. (*A.M. 1928*) (*Sec.-Treas., Niagara Peninsula Br., E.I.C.*)

DEWIS, Clifford Sayre, Chief Engr., Canmore Coal Co. Ltd., Box 337, Canmore, Alta. (*A.M. 1917*)

DeWOLFE, Wm. Joseph, Asst. City Engr., City of Halifax, City Hall, Halifax, N.S. (*H*) 106 Henry St. (*A.M. 1906*)

DEXTER, J. D., B.Eng., (McGill '32), Brooklyn, Queen's Co., N.S. (*S. 1932*)

DEY, Victor A. G., Div. Engr., Bruce Div., C.P.R., Rm. 344, Union Sta., Toronto, Ont. (*H*) 64 Westmount Ave. (*S. 1904*) (*A.M. 1909*) (*M. 1928*)

DIBBLEE, Harrie Miles, Res. Engr., C.P.R., c/o Chief Engr.'s Office, Windsor Station, Montreal, Que. (*S. 1895*) (*A.M. 1906*)

DICK, Geo. M., B.Sc., (McGill '24), Mech. Engr., Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) 24 Walton Ave. (*S. 1922*) (*A.M. 1928*)

DICK, James, Vice-Pres., Morrow & Beatty Ltd., Peterborough, Ont. (*H*) 139 Fourth Ave., Ottawa, Ont. (*S. 1906*) (*A.M. 1909*)

DICK, Victor Wm., B.Sc., E.E., (Man. '21), Operator, Northwestern Power Co. Ltd., Seven Sisters Falls, Man. (*S. 1920*) (*Jr. 1922*) (*A.M. 1930*)

†DICK, W. J., B.Sc., M.Sc., Pres., Cadomin Mines, 311 McLeod Bldg., Edmonton, Alta. (*H*) 11326–99th Ave. (*A.M. 1911*) (*M. 1918*)

DICKENSON, J. G., B.A., B.Sc., (McGill '07), Gen. Mines Mgr., M. J. O'Brien, Ltd.; Pres., Can. Flint and Spar; Vice-Pres., O'Brien & Fowler Ltd.; Gen. Mgr., O'Brien Gold Mines Ltd., 140 Wellington St., Ottawa, Ont. (*H*) 318 Lisgar Rd., Rockcliffe. (*S. 1905*) (*A.M. 1912*) (*M. 1919*)

DICKEY, H. P., B.Sc., (Queen's '30), Teck Hughes Gold Mines, Kirkland Lake, Ont. (*H*) 339 Wentworth St. S., Hamilton, Ont. (*S. 1928*)

♂DICKIESON, Arthur Logan, M.Sc., (McGill '10), Elec. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 385 Reid St. (*A.M. 1920*)

DICKINSON, John A., 1214 Graham Blvd., Montreal, Que. (*Jr. 1918*) (*A.M. 1920*)

DICKSON, Archibald, Chief Dftsman., Dom. Bridge Co. Ltd., Calgary, Alta. (*H*) 103–11th Ave. N.W. (*A.M. 1934*)

DICKSON, Garnet Horace, B.Sc., (McGill '09), Sales Engr., Babcock-Wilcox & Goldie-McCulloch Ltd., 312 Canada Cement Bldg., Montreal, Que. (*H*) 373 Prince Albert Ave., Westmount, Que. (*S. 1911*) (*A.M. 1916*)

DICKSON, Geo. Leslie, M.A., (Acadia '00), Elec. and Signal Engr., C.N.R., Moncton, N.B. (*H*) 78 Gordon St. (*A.M. 1923*)

♂DICKSON, Thomas H., B.Sc., (N.S.T.C. '22), Supervisor of Unit Cars, C.N.R., Moncton, N.B. (*H*) 14 West St. (*Jr. 1920*) (*A.M. 1929*)

DICKSON, Wallace, B.Sc., (McGill '07), Asst. Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 2501 Monsabre St. (*A.M. 1915*) (*M. 1920*)

DICKSON, Wm. Leslie, B.Sc., (N.S.T.C. '29), N.B. Electric Power Comm., Newcastle Creek, N.B. (*S. 1930*)

DICKSON, Wm. Lochead, B.A.Sc., (Tor. '15), 317½ Oakwood Ave., Toronto, Ont. (*S. 1914*) (*A.M. 1924*)

DILL, Edwin W., B.A.Sc., (Tor. '28), Asst. Refinery Engr., The British American Oil Co., Ltd., Toronto, Ont. (*S. 1929*)

DILWORTH, Edwin Leslie, B.Sc., (Queen's '25), Can. Blower and Forge Co., Ltd., Kitchener, Ont. (*S. 1924*) (*A.M. 1931*)

♂DINGWALL, Robert M., Man'g. Dir., Standard Iron Works Ltd., 121st St. and 106th Ave., Edmonton, Alta. (*H*) 10224–131st St. (*A.M. 1923*)

DION, J. E., B.Sc., (McGill '26), 431 Mt. Pleasant Ave., Westmount, Que. (*S. 1922*) (*Jr. 1927*) (*A.M. 1932*)

♂DIXON, G. Bruce, B.Sc., (N.B. '12), Dyking Commr., Dykes Dept., B.C., Court House, New Westminster, B.C. (*H*) 526–4th St. (*Jr. 1914*) (*A.M. 1923*)

DIXON, Howard Alex., B.A.Sc., (Tor. '01), O.L.S., M.L.S., Chief Engr., Western Lines, C.N.R., Winnipeg, Man. (*A.M. 1908*)

DIXON, Leon Snell, B.S. in M.E., Cons. Engr., Box 744, Station F, Toronto, Ont. (*A.M. 1921*) (*M. 1923*)

DIXON, Meredith F., B.Sc., (McGill '30), 2281 Wilson Ave., Montreal, Que (*S. 1924*)

♂DOANE, Francis W. W., Lt.-Col., Cons. Engr., Doane Engineering Co., Halifax, N.S. (*H*) 25 Young Ave. (*S. 1887*) (*A.M. 1889*) (*M. 1892*) (*Life Member*)

♂DOANE, H. W. L., Major, B.Sc., (N.S.T.C. '13), Constrn. Engr., Standard Paving (Maritime) Ltd., Capitol Theatre Bldg., Halifax, N.S. Address: Bedford, N.S. (*A.M. 1919*) (*M. 1923*)

DOBBIN, David C., B.Eng., (McGill '32), Dom. Rubber Co. Ltd., St. Jerome, Que. (*H*) 2095 Grey Ave., N.D.G., Montreal, Que. (*S. 1931*)

DOBBIN, Ross Leonard, B.A.Sc., (Tor. '11), Gen. Mgr., Utilities Comm., 223 Aylmer St., Peterborough, Ont. (*H*) 295 Reid St. (*Member of Council, E.I.C.*) (*S. 1910*) (*A.M. 1914*) (*M. 1919*)

♂DOBBIN, W. Leslie, Capt., B.A.Sc., (Tor. '16), Vice-Pres., The Grant Contracting Co. Ltd., 47 Wellington St. E., Toronto, Ont. (*H*) 145 Strathallen Blvd. (*S. 1915*) (*A M. 1921*)

DOBIE, Robert, 4 Kirk St., Peterborough, Ont. (*M. 1926*)

DOBRIDGE, Ronald Wemyss, Trans. Engr., Can. Marconi Co., Town of Mt. Royal, Que. (*H*) 41 Dobie Ave., Town of Mt. Royal, Que. (*S. 1928*)

DOBSON, R. Nesbitt, B.Eng., (McGill '35), Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 6645 Molson St., Montreal, Que. (*S. 1933*)

DOBSON, Wm. Percy, B.A.Sc., M.A.Sc., (Tor. '11), Chief Testing Engr., H.E.P.C. of Ont., 8 Strachan Ave., Toronto, Ont. (*H*) 241 Riverside Drive. (*M. 1920*)

DOBSON-SMITH, C. F., Engr. i/c Bldgs., Project No. 44, Dept. National Defence, Dundurn Camp, Dundurn, Sask. (*H*) Rosetown, Sask. (*S. 1935*)

♂DODD, Geoffrey Johnstone, Lieut., M.Sc., (McGill '22), Assoc. Prof. of C.E., McGill University, Montreal, Que. (*H*) 209 Carlyle Road, Town of Mount Royal, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1920*)

DODDRIDGE, P. W., B.Sc., (N.B. '28), Sales, Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 39 Wineva Ave. (*S. 1928*)

†DODGE, G. Blanchard, D.L.S., Chief Control Surveys Div., Topographical Survey, Dept. Interior, Ottawa, Ont. (*H*) 26 Broadway. (*A.M. 1907*) (*M. 1911*) (*Life Member*)

♂DOHERTY, Chas. Alexander, Major, Castlegate House, Grantham, Lincs., England. (*S. 1914*) (*A.M. 1922*)

DOHERTY, Thos. Hugh, B.Sc., (McGill '29), National Research Council, 79 Sussex St., Ottawa, Ont. (*S. 1928*)

DONALD, James Richardson, B.A., B.Sc., (McGill '13), Pres., Donald-Hunt Ltd., 1181 Guy St., Montreal, Que. (*H*) 527 Lansdowne Ave. (*A.M. 1921*) (*M. 1927*)

DONALDSON, Christopher Storrar, Dir. and Mine Mgr., Lethbridge Collieries Ltd., Lethbridge, Alta. (*H*) 924–7th Ave. S. (*A.M. 1925*)

DONALDSON, J. Logie, B.A.Sc., (Tor. '33), 229 Bay St. S., Hamilton, Ont. (*S. 1932*)

♂DONCASTER, Purcell Eli, Lieut., Dist. Engr., D.P.W., Canada, Post Office Bldg., Fort William, Ont. (*H*) 98 Winnipeg Ave., Port Arthur, Ont. (*A.M. 1911*) (*M. 1918*)

♂DONKIN, Charles Harold Foster, 73 Spring St., Amherst, N.S. (*A.M. 1921*)

♂DONNELLY, Chas. Hibbert, B.A., B.Sc., (Queen's), Tech. Asst. to Supt., American Can Co., Simcoe, Ont. (*H*) 111 Colborne St. (*S. 1919*) (*A.M. 1922*)

♂DONNELLY, Harold H., Major, Associated Screen News Co., 5271 Western Ave., Montreal, Que. (*H*) 4599 Harvard Ave. (*S. 1908*) (*A.M. 1913*)

DONNELLY, Wm. David, B.Sc., (Queen's '25), Can. Johns-Manville Co. Ltd. Address: New Iroquois Hotel, Asbestos, Que. (*S. 1924*)

DONOHOE, G. M., B.Sc., (N.B. '31), 102 Guilford St., Saint John, N.B. (*S. 1931*)

DONOHUE, E. W., 3589 St. Famille St., Montreal, Que. (*S. 1923*)

DORAN, Henry T., Mgr., Montreal Office, Dom. Flow Meter Co. Ltd.; Whiting Corp. (Canada) Ltd.; Diesel Power Ltd., Rm. 11, 1188 Phillips Place, Montreal, Que. (*H*) 24 Springfield Ave., Westmount, Que. (*A.M. 1925*)

DORE, Jackson Ira, B.Sc., (Queen's '30), Chemist, Customs-Excise Chemical Lab., Dept. of National Revenue, Ottawa, Ont. (*H*) 16 Aylmer Ave. (*S. 1928*)

DORE, Richard F., B.Sc. (Queen's '32) Geological Survey of Canada, Dept. of Mines, Ottawa, Ont. (*H*) 16 Aylmer Ave. (*S. 1932*)

♂DORION, Robert, B.A.Sc., (Ecole Polytech., Montreal '22), City Engr., Lachine, Que. (*H*) 169-A 18th Ave. (*S. 1920*) (*A.M. 1926*)

♂DORMER, Wm. John Smylie., B.Sc., (McGill'23) Dist. Engr., The Bell Telephone Co. of Canada, Beaver Hall Bldg., Montreal, Que. (*H*) 4038 Beaconsfield Ave., N.D.G. (*S. 1920*) (*Jr. 1927*) (*A.M. 1933*) (*M. 1935*)

DORRANCE, Frank Young, C.E., (Renss. '06), Div. Engr., Montreal Water Bd., Joseph St., Verdun, Que. (*H*) 341 Brock Ave. North, Montreal West, Que. (*A.M. 1915*)

†DOTY, John W., C.E., (Renss.) Pres., The Foundation Co., 120 Liberty St., New York, N.Y. (*H*) Noroton, Conn. (*A.M. 1913*) (*M. 1913*)

DOUCET, Jean, 10841 Berthelet St., Montreal, Que. (*S. 1935*)

DOUGLAS, Arnold Howard, B.Sc., (Sask. '31), Indian Head, Sask. (*S. 1931*)

♂DOUGLAS, George Vibert, Capt., M.C., M.Sc., (McGill '20), Prof. of Geology, Dalhousie University, Halifax, N.S. (*Jr. 1920*) (*A.M. 1921*)

DOUGLAS, James A., 493 Wardlaw Ave., Winnipeg, Man. (*S. 1890*) (*A.M. 1901*) (*M. 1917*) (*Life Member*)

DOUGLAS, John Holden Webb., Mech. Supt., D.P.W. Alta., Edmonton, Alta. (*H*) 10937-90th Ave. (*A.M. 1935*)

DOULL, Robert Morse, B.Sc., (McGill '29), Asst. Mgr., Construction Equipment Co., 1200 Benoit St., Montreal, Que. (*H*) 4820 Grosvenor Ave. (*S. 1927*) (*Jr. 1934*) (*A.M. 1934*)

DOUPE, Jacob Lonsdale, M.A., (Man. '87), D.L.S. and L.S. for Man., Sask., Alta., B.C., Chief Surveyor, Engrg. Dept., Western Lines, C.P.R., Winnipeg, Man. (*M. 1920*)

DOVE, Allan Burgess, B.Sc., (Queen's '32), Chem. Engr. and West Mill Supt., Steel Co. of Canada, Ltd., Hamilton, Ont. (*H*) Apt. 16, Wentworth Apts. (*S. 1932*) (*Jr. 1934*)

DOW, John, Plant Dept., Alberta Government Telephones, 6th Ave. W., Calgary, Alta. (*H*) 609-22nd Ave. W. (*M. 1922*)

DOW, Gordon Young, B.Sc., (N.B. '32), Pacific Dairies Ltd. (*H*) 146 Mecklenburg St., Saint John, N.B. (*S. 1934*)

DOWD, Frank Eugene Victor, Asst. Supt. Engr., Water and Sewerage Divn., D.P.W., City of Montreal, City Hall, Montreal, Que. (*H*) 5348 Duquette Ave. (*Jr. 1915*) (*A.M. 1920*)

DOWLING, Harry Lawson, B.A.Sc., (Tor. '19), Can. and General Finance Co. Ltd., 25 King St. W., Toronto, Ont. (*S. 1919*) (*A.M. 1922*)

DOWNES, M. Augustine, B.Sc., (McGill '12), Asst. Engr., Technical Service, City of Montreal. (*H*) 3985 Laval Ave., Montreal, Que. (*S. 1911*) (*Jr. 1917*) (*A.M. 1930*)

♂DOYE, Marius, Cons. Marine Companies, Ltd., Marine Bldg., 1405 Peel St., Montreal, Que. (*H*) 2540 St. Catherine Rd. (*A.M. 1925*)

♂DRAKE, Robert Ludlow, Jr. Engr., Reclam. Service, Dept. Inter., Ottawa, Ont. (*Jr. 1923*)

DREW, Arthur Edward, B.Sc., (Sask. '27), Merritt Chapman & Scott, Corp., Savannah, Ga., U.S.A. (*A.M. 1930*)

DREWRY, William Stewart, D.L.S., O.L.S., B.C.L.S., 727 Linden Ave., Victoria, B.C. (*A.M. 1887*) (*Life Member*)

DROLET, J. H. A. E., B.S., (Ecole Polytech., Montreal '09), Vice-Pres. and Foundry Supt., La Cie F. X. Drolet, Quebec, Que. (*H*) 93 Ste. Foye Road. (*S. 1909*) (*A.M. 1919*)

DRUMMOND, Robt., Asst. Mgr., Anglin-Norcross, Ltd., 57 Bloor St. W., Toronto, Ont. (*H*) Port Credit, Ont. (*S. 1922*)

DRYSDALE, William F., B.Sc., (McGill '04), Vice-Pres., Montreal Locomotive Works, Ltd.; Vice-Pres., Can. Steel Tire and Wheel Co., 215 St. James St., Montreal, Que. (*H*) 418 Pine Ave. W. (*S. 1904*) (*A.M. 1911*) (*M. 1919*)

Du BOIS, M., B.A. Dipl. Ing., M.Sc., Mech. Eng. Asst. to Dir., Sulzer Bros. Ltd. Address: St. Georgen Str. 35, Winterthur, Switzerland. (*Jr. 1928*)

DUBREUIL, L. Adrian, B.A.Sc. (Ecole Polytech., Montreal '16), Supt. Engr., Dufresne Construction Co. Ltd., 1832 Blvd. Pie IX, Montreal, Que. (*H*) 1212 St. Matthew St. (*S. 1913*) (*A.M. 1921*)

♂DUBUC, Arthur Edouard, Col., D.S.O. and Bar, V.D., Chevalier de la Légion d'Honneur, etc., B.A.Sc., Chief Engr., Dept. of Rlys. and Canals, Ottawa, Ont. (*H*) 63 Roxborough Apts. (*S. 1899*) (*A.M. 1906*) (*M. 1917*)

♂DuCANE, Charles George, Lt.-Col., O.B.E., Partner, Sir John Wolfe Barry & Partners, Dartmouth House, 2 Queen Anne's Gate, London, S.W.1. (*H*) "Lightoaks," Moor Park, Rickmansworth, England. (*A.M. 1912*) (*M. 1913*)

DUCHASTEL de MONTROUGE, Baron Jules A., Major, B.A.Sc., (Ecole Polytech., Montreal '01), Mgr., The Quebec Forest Industries Assoc., Ltd., Price House, P.O. Box 174, Quebec, Que. (*S. 1899*) (*A.M. 1904*) (*M. 1912*)

DUCHASTEL de MONTROUGE, Leon A., B.A.Sc., (Ecole Polytech., Montreal '27), Designer and Power Sales Engr., Shawinigan Water and Power Co., 107 Craig St. W., Montreal, Que. (*H*) 3289 Van Horne Ave., Outremont, Que. (*S. 1925*) (*Jr. 1933*)

Du CHENE, Andrew Hubert, B.Sc., (N.B '30), Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*Jr. 1934*)

DUCKWORTH, Walter R., Plant Engr. and Asst. Supt., Dom. Bridge Co. Ltd., 275 W. 1st Ave., Vancouver, B.C. (*H*) 3337–3rd Ave. W. (*A.M. 1902*)

♂DUCLOS, L. Murray, Asst. Engr., C.P.R., North Bay, Ont. (*H*) 158 Copeland St. (*Jr. 1921*) (*A.M. 1926*)

DUFF, Clemens V., B.Sc., (N.S.T.C. '33), Stellarton, N.S. (*S. 1933*)

DUFF, Wm. Alexander, (Tor. '01), Engr. of Bridges and Roadways, C.N.R., 355 McGill St., Montreal, Que. (*H*) Apt 518, Drummond Court Apts. (*S. 1900*) (*A.M. 1905*) (*M. 1919*)

DUFFY, David Auriel, City of Saint John, City Hall, Saint John, N.B. (*A.M 1920*)

♂DUFFY, Rob Roy, Lieut., B.Sc., (Acadia '10), B.Sc., (McGill '13), Q.L.S., Asst. Sales Mgr., Price Bros. & Co. Ltd., Etchemin Bridge, Que. (*A.M. 1926*)

DUFRESNE, Alex. R., B.A.Sc., (McGill '96), Chief Engr. and Dir., Can. Dredge and Dock Co., 805 Dominion Square Bldg., Montreal, Que. (*H*) 4864 Cote des Neiges Rd. (*S. 1894*) (*A.M. 1902*) (*M. 1911*)

DUFRESNE, Alphonse Olivier, B.A.Sc., (Ecole Polytech., Montreal '11), B.Sc., M.Sc., (McGill '13), Director, Quebec Bureau of Mines, Parliament Bldg., Quebec, Que. (*H*) 96 Lachevrotiere St. (*M. 1935*)

K.G. †DUGGAN, Geo. Herrick, D.Sc., (Tor. '83), LL.D., (Queen's), LL.D., (McGill), President, Dom. Bridge Co., Ltd., Montreal, Que. (*H*) 3636 McTavish St. (*A.M. 1888*) (*M. 1890*) (*Past President*)

♂DUGUID, A. Fortescue, Col., D.S.O., B.Sc., (McGill '12), Dir., Historical Section G.S., Dept. National Defence, Ottawa, Ont. (*H*) 72 Buena Vista Rd., Rockcliffe Park. (*S. 1912*) (*A.M. 1923*)

DUMAS, Albert Victor, B.Sc., (M.I.T. '20), Prof., Ecole Technique de Québec, 185 Langelier Blvd., Quebec, Que. (*H*) 1092¼ St. Valier St. (*A.M. 1929*)

DUMONT, G. H., Amos, Que. (*S. 1935*)

DUMONT, Joseph, Rd. Engr., Dept. of Colonization, Mines and Fisheries, Prov. Quebec, Amos, Que. (*A.M. 1920*)

♂DUNBAR, Jas. Bevan Plenoerleath, Lt.-Col., (R.M.C. Kingston '09), A.A. and Q.M.G., M.D. No. 6, Halifax, N.S. (*A.M. 1925*)

†DUNBAR, John R., B.Sc., E.E., (McGill '20), Elec. Engr., Can. Westinghouse Co., Hamilton, Ont. (*H*) 26 Fairleigh Ave. S. (*S. 1917*) (*Jr. 1922*) (*A.M. 1927*)

♂DUNBAR, William Bowie, Lieut., B.A.Sc., (Tor. '12), Asst. Prof. of Engrg. Drawing, University of Toronto, Toronto, Ont. (*H*) 241 Glebeholme Blvd. (*A.M. 1921*)

♂DUNCAN, Geo. Marr, Designing Engr., P.W.D., B.C., Victoria, B.C. (*H*) 443 Durban St. (*M. 1934*)

DUNCAN, Gaylen R., Jr., B.Eng., (McGill '35), 318 S. Archibald St., Fort William, Ont. (*S. 1935*)

DUNCAN, G. Rupert, M.Sc., (McGill '01), Prop., G. R. Duncan & Co., 426 Victoria Ave., Fort William, Ont. (*H*) 318 S. Archibald St. (*S. 1899*) (*A.M. 1902*)

♂DUNCAN, Jas. Edgar, B.Sc., (Man. '23), 970 McMillan Ave., Winnipeg, Man (*S. 1922*) (*Jr. 1925*) (*A.M. 1931*)

DUNCAN, John D., B.A.Sc., (B.C. '28), Sales Engr., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*S. 1928*)

♂DUNCAN, John Moyle, Engr. Lieut., B.A.Sc., (Tor. '10), Engr., Atmospheric Nitrogen Corp., Hopewell, Va., U.S.A. (*H*) 1578 Berkeley Ave., Petersburg, Va. (*A.M. 1924*)

♂DUNCAN, W. E. P., Major, B.Sc., (Glasgow '13), Engr. of Structures, Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 19 Rochester Ave. (*S. 1911*) (*A.M. 1919*)

DUNLAP, Clarence R., B.Sc., (N.S.T.C. '28), R.C.A.F., Camp Borden, Ont. (*S. 1928*)

DUNLOP, Duthie MacI., B.Sc., (Man. '34), 128 Arlington St., Winnipeg, Man. (*S. 1934*)

DUNLOP, J. Russell, B.Eng., (McGill '35), 184 Primrose Ave., Ottawa, Ont. (*S. 1935*)

DUNLOP, Robt. J. F., B.Eng., (McGill '32), Belding-Corticelli Ltd., Montreal, Que. (*H*) Apt. 4, 3739 Hutchison St. (*S. 1930*)

DUNLOP, Ronald Wm., B.A.Sc., (Tor. '27), Mech. Engr., Imperial Oil Ltd., Calgary, Alta. (*H*) 823-15th Ave. W. (*Jr. 1928*)

†DUNN, Guy C., Quyon, Que. (*A.M. 1887*) (*M. 1897*) (*Life Member*)

♂DUNN, Harold Stewart, Lieut., Supt. Construction, William Cooke Co., North Sydney, N.S. (*H*) 4 Cromarty St., Sydney, N.S. (*A.M. 1931*)

DUNN, Wm. Kenneth, B.Sc., (McGill), 1441 Drummond St., Montreal, Que. (*S. 1928*)

DUNNE, Hugh Joseph, Asst. Engr., D.P.W., Ottawa, Ont. (*H*) 10 Russell Ave. (*A.M. 1921*)

DUNPHY, Kenneth Austin, B.Sc., (N.B. '07), Div. Engr., C.P.R., Fort William, Ont. (*H*) 315 Catherine St. (*A.M. 1920*)

♂DUNSMORE, Robt. Lionel, Major, B.Sc., (Queen's '15), Supt., Halifax Refinery, Imperial Oil Ltd., P.O. Box 490, Dartmouth, N.S. (*A.M. 1924*)

DUPERRON, Arthur, B.A.Sc., (Ecole Polytech., Montreal '11), Chief Engr., Montreal Tramways Comm., 159 Craig St. W., Montreal, Que. (*H*) Apt. 1, 1833 Sherbrooke St. E. (*A.M. 1919*) (*M. 1928*)

♂DUPONT, Georges, M.A., C.E., (Address unknown). (*A.M. 1908*)

♂DUPRE, Henry Augustus, Lieut., M.C., Asst. Dir., Elec. and Gas Inspection, Elec. Stds. Lab., Dept. of Trade and Commerce, Ottawa, Ont. (*H*) 319 McLeod St. (*A.M. 1914*) (*M. 1920*)

DUPUIS, Louis Charles, Div. Engr., C.N.R., Levis, Que. (*H*) 11 deSalaberry Ave., Quebec, Que. (*Jr. 1922*) (*A.M. 1919*)

DUPUIS, Phil. Aug., B.A.Sc., (Ecole Polytech., Montreal '21), Sr. Engr., D.P.W., Rm. 7, Parliament Bldg., Quebec, Que. (*A.M. 1934*)

DUPUIS, René, B.A., Asst. Supt., Power Divn., Quebec Power Co., Quebec, Que. (*H*) 123 Marquette St. (*A.M. 1934*)

DURANT, Selwyn Eld., C.P.R., Box 117, Lloydminster, Sask. (*A.M. 1921*)

DURDAN, F. S., B.Sc., (Queen's '33), 1311 River Rd., Niagara Falls, Ont. (*S. 1933*)

DURHAM, G. D., (Queen's '29), 699 Jepson St., Niagara Falls, Ont. (*S. 1928*)

†DURLEY, Richard John, Ma.E., General Secretary, The Engineering Institute of Canada, 2050 Mansfield St., Montreal, Que. (*H*) 3174 The Boulevard, Westmount, Que. (*A.M. 1897*) (*M. 1904*)

DURLEY, Thos. Richard, B.Sc., (McGill '28), Asst. Supt., Plant No. 1, Canada Cement Co. Ltd., Montreal, Que. (*H*) Apt. 1, 5235 Cote St. Luc Rd. (*S. 1926*) (*Jr. 1931*)

DURNIN, Edward Jas., B.Sc., (Man. '28), Asst. Supt., Saskatchewan Power Comm., Saskatoon Plant, Saskatoon, Sask. (*H*) 1004 Temperance St. (*Jr. 1930*)

DUSCHAK, Ernest A., C.E., (Cornell '06), Mech. Supt., Imperial Oil Refineries, Ltd., Regina, Sask. (*H*) 675 Winnipeg St. (*A.M 1921*)

♂DUSTAN, Ernest Bruce, B.A.Sc., (Tor. '20), Station Design Dept., H.E.P.C. of Ont., Toronto, Ont. (*Jr. 1921*) (*A.M. 1926*)

DUTTON, Wm. L., B.A.Sc., (Tor. '31), O.L.S., Engr., Nat. Gas Divn., Union Natural Gas Co., Gas Bldg., Chatham, Ont. (*H*) 3 Ellwood Ave. (*S. 1930*) (*Jr. 1935*)

DWYER, J. N., Office and Fld. Asst., D.P.W., Game and Fisheries, Biological Bldg., McGill University, Montreal, Que. (*S. 1931*)

DWYER, Michael, The Hon., Minister of P.W.M. and L., Province House, Halifax, N.S. (*A.M. 1925*)

DYER, Arthur F., Chief Engr., McDonald Construction Co., Halifax, N.S. (*H*) 270 South St. (*A.M. 1918*)

DYER, Edmund Gerald, 16 Merkle St., Halifax, N.S. (*S. 1934*)

DYER, Frederick Charles, B.A.Sc., (Tor. '09), Prof., Dept. of Mining Engineering, University of Toronto, Toronto, Ont (*H*) 164 Colin Ave. (*M. 1920*)

DYER, John Henry, B.Sc., (N.S.T.C. '28), 16 Merkle St., Halifax, N.S. (*S. 1928*)

DYER, J. Wilson, B.A.Sc., (Tor. '23), Vehicles Superv., Bell Telephone Co. of Canada, 902 Canada Permanent Bldg., Toronto, Ont. (*H*) Apt. 12, 1 Triller Ave. (*S. 1921*) (*Jr. 1926*) (*A.M. 1930*)

DYER, Walter Gerald, B.Sc., (Sask. '25), C.P.R., Regina, Sask. (*H*) 11 Mayfair Apts. (*A.M. 1934*)

♂DYKE, Fred. Stanley, Capt., Asst. Engr., W.W. Dept., City of Calgary, City Hall, Calgary, Alta. (*H*) 211-38th Ave., S.W. (*A.M. 1915*)

DYMENT, John T., B.A.Sc., (Tor. '29), Jr. Engr., Airworthiness Div., Dept. of National Defence, Ottawa, Ont. (*H*) 14 Middleton Drive. (*S. 1925*

♂EADIE, Robert Scott, Lieut., B.Sc., M.Sc., (McGill '22), Designing Engr., Dominion Bridge Co. Ltd., Box 4016, Montreal, Que. (*H*) 4380 Mayfair Ave. (*S. 1914*) (*Jr. 1920*) (*A.M. 1926*)

EAGER, Norman H. A., B.Sc., (McGill '22), M.C.E., (Cornell '23), Indust. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 4312 Montrose Ave., Westmount, Que. (*Jr. 1925*) (*A.M. 1934*)

EAGLES, Norman Boroen, B.Sc., (N.B. '35), 110 Cornhill St., Moncton, N.B. (*S. 1935*)

EARDLEY-WILMOT, Trevor, B.Sc., (McGill '13), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 2175 Lincoln Ave. (*Jr. 1916*) (*A.M. 1919*)

♂EARL, Ernest A., Capt., Area Mgr., F. Chambers & Co. Ltd., The Pencil Works, Stapleford, Notts., England. (*A.M. 1911*) (*M. 1925*)

EASTLAKE, William H., B.A., (Tor. '12), Asst. Gen. Supt, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 143 Lazard Rd., Town of Mount Royal, Que. (*A.M. 1921*)

EASTON, Frank Stewart, B.Sc., (Eng.), (Glasgow '06), (A.R.T.C., Glasgow '03), Chief Civil Engr., Mexican Light and Power, and Mexico Tramways Co., Apartado 124 Bis, Mexico, D.F. (*A.M. 1915*) (*M. 1922*)

♂EASTWOOD, D. Ross, B.A.Sc., (Tor. '27), Asst. Engr., Can. Celanese Ltd., Drummondville, Que. (*A.M. 1931*)

G. ♂EATON, Milton, B.Sc., (McGill '21), Elec. Engr., Shawinigan Chemicals Ltd., Shawinigan Falls, Que. (*H*) 41-9th St. (*S. 1920*) (*A.M. 1925*)

ECKENFELDER, George, B.Sc., (Alta. '33), Asst. Engr., Dept. National Defence U.R.P., Yahk, B.C. (*S. 1932*)

♂EDDY, A. C., Capt., Engr. of Way, B.C. Electric Rly., Vancouver, B.C. (*H*) 1620 Burnaby St. (*M. 1914*)

EDDY, Harrison P., B.Sc., (Worcester '91), D.Eng., '30, Partner, Metcalf & Eddy, 1300 Statler Bldg., Boston, Mass. (*H*) 85 Gray Cliff Rd., Newton Centre, Mass. (*M. 1926*)

♂EDGAR, John H., Major, B.Sc., (McGill '03), Inspr. of Materials, C.N.R., P.O. Box 2909, Winnipeg, Man. (*S. 1903*) (*A.M. 1910*)

♂EDMONDS, Chas. Wm., B.A.Sc., (Tor. '19), Supt., Canada Cement Co. Ltd., Fort Whyte, Man. (*S. 1914*) (*Jr. 1921*) (*A.M. 1924*)

♂EDWARDS, Charles Peter, Lt.-Comdr., O.B.E., Director of Radio, Dept. of Marine, Rm. 220, Hunter Bldg., Ottawa, Ont. (*H*) 454 Cloverdale Rd., Rockcliffe, Ont. (*A.M. 1916*)

♂EDWARDS, Norman I. E., D.S.M., Franklin Rly. Supply Co. of Canada, 805 Confederation Bldg., Montreal, Que. (*A.M. 1921*)

EGGERTSON, E. Gretier, B.Sc., (Man. '25), 1101 McArthur Bldg., Winnipeg, Man. (*S. 1924*) (*A.M. 1930*)

EHLY, L. J., 10041-111th St., Edmonton, Alta. (*S. 1930*)

ELDERKIN, Karl Osler, B.Sc., (McGill '20), Mgr., International Power and Paper Co. of Nfld., Corner Brook, Nfld. (*S. 1920*) (*Jr. 1920*) (*A.M. 1929*)

ELEY, Fred C., B.A.Sc., (Tor. '21), Sales Engr., Amalgamated Electric Corp., Ltd., 372 Pape Ave., Toronto, Ont. (*H*) 62-B Summerhill Gardens. (*S. 1921*) (*Jr. 1926*)

♂ELGEE, H. A., Capt., B.A., B.A.I., (T.C.D.), 9 Copplestone Rd., Budleigh Salterton, Devon, England. (*M. 1914*)

ELKINGTON, G. E., B.Sc., (McGill '23), Oper. Engr., East Kootenay Power Co. Ltd., P.O. Box 67, Fernie, B.C. (*S. 1919*) (*Jr. 1928*) (*A.M. 1933*)

ELLACOTT, Chas. Herbert, B.Sc., (McGill), B.C.L.S., D.L.S., Project No. 40, Dept. National Defence, Petawawa, Ont. (*H*) 123 Beverley Ave., Kingston, Ont. (*S. 1888*) (*A.M. 1899*) (*M. 1921*) (*Life Member*)

ELLIOT, Donald Geo., B.Sc., (Edinburgh '30), Anglo-Newfoundland Development Co., Grand Falls, Nfld. (*S. 1930*) (*Jr. 1934*)

ELLIOT, G. B., B.Sc., (McGill '23), Carrier Corp. of Canada, 620 Cathcart St., Montreal, Que. (*H*) 4608 Decarie Blvd. (*S. 1922*) (*Jr. 1926*) (*A.M. 1930*)

ELLIOT, Laurie B., B.Sc., (Dalhousie '03), Sr. Asst. Engr., D.P.W., Canada, New Westminster, B.C. (*H*) 521-3rd St. (*S. 1902*) (*A.M. 1909*) (*M. 1919*)

ELLIOTT, Chas. C., Canal Supt., Dept. Nat. Res., C.P.R., Box 80, Brooks, Alta. (*A.M. 1919*)

ELLIOTT, J. Courtney, B.Sc., (Queen's '34), Southern Ontario Gas Co., Box 419, Leamington, Ont. (*H*) 5 Marlboro St. (*S. 1934*)

ELLIOTT, Lisgar Webster, B.Sc., (Alta. '33), Can. Marconi Co., Town of Mt. Royal, Que. (*H*) 301 Brookfield Ave. (*S. 1933*) (*Jr. 1935*)

♂ELLIS, Douglas Stewart, Lt.-Col., D.S.O., M.C., M.A., B.Sc., (Queen's '10), D.L.S., O.L.S., Prof. of C.E., Queen's University, Kingston, Ont. (*H*) 418 Earl St. (*S. 1909*) (*Jr. 1913*) (*A.M. 1919*)

ELLIS, John Attwill, Asst. Engr., C.N.R., Rm. 603, Can. Express Bldg., McGill St., Montreal, Que (*H*) 61 Nelson Ave., Montreal West, Que. (*A.M. 1921*)

ELLSWORTH, Arthur Crayton, B.Sc., (Queen's '35), Ridgeway, Ont. (*S. 1934*)

EMERSON, Robert Alton, B.Sc., (Man. '30), Box 24, Morden, Man. (*S. 1929*) (*Jr. 1932*)

EMERY, Donald Jos., 205 Rutherford St., Peterborough, Ont. (*S. 1927*)

EMMERSON, Robert H., Chief Engr.'s Office, C.N.R., Moncton, N.B. (*H*) 231 Highfield St. (*S. 1908*) (*A.M. 1913*)

♂EMRA, Frederic H., Lieut.-Col., O.B.E., F. H. Emra and Partners, Civil Cons. Engrs., 604 Hope Chambers, Ottawa, Ont. (*H*) 87 Catherine St. (*S. 1908*) (*A.M. 1912*) (*M. 1919*)

♂EMREY, Desmond Jospeh, Capt., M.C., M.M., B.Sc., (Queen's '22), County Engr., Corp. County of Waterloo, Court House, Kitchener, Ont. (*H*) 37-B Ahrens St. W. (*S. 1914*) (*Jr. 1920*) (*A.M. 1922*)

ENGEL, Nathan Louis, B.Sc., (McGill '07), Montreal L. H. and P. Cons., Power Bldg., Montreal, Que. (*A.M. 1921*)

ENNIS, Leo. E., B.Sc., (Queen's '23), Dist. Plant Engr., The Bell Telephone Co. of Canada, Quebec, Que. (*H*) Apt. 2, 69 Laurentide Ave. (*S. 1922*) (*A.M. 1931*)

ERICKSON, M. A., Scandia, Alta. (*S. 1935*)

ERICSON, Charles G., LL.B., (Valparaiso '04), Mech. Engr., Canada Machinery Corp , Ltd., 704 Bank of Hamilton Bldg., Toronto, Ont. (*H*) 58 Alvin Ave., Toronto, Ont. (*A.M. 1921*)

ERIKSEN, Erik, C.E., (Trond '05), Str'l Dftsman, C.N.R., Rm. 433, Union Station, Toronto, Ont. (*H*) 49 Melrose Ave. (*A.M. 1921*)

ERIKSEN, Gudmund, (Grad Oslo), Asst. Engr., City Engr's Dept., Port Arthur, Ont. (*H*) 41 Elm St. (*A.M. 1932*)

♂ERVINE-GRIM, W. A., Capt., Cons. Engr., Apartado 1066, Tampico, Tamps, Mexico. (*A.M. 1909*) (*M. 1919*)

ESDAILE, H M., 3450 Melrose Ave., N.D.G., Montreal, Que. (*S. 1934*)

ESMOND, Douglas C., B.Eng., (McGill '33), 3592 University St., Montreal, Que. (*S. 1934*)

EVANS, Chas. D., B.Sc , (McGill '24), Sales Mgr., Can. Gypsum Co. Ltd., 1108 Dominion Square Bldg., Montreal, Que. (*H*) 2562 Mt. Clair Ave., N.D.G. (*Jr. 1930*)

EVANS, D. Arthur, Lake St. John Power and Paper Co. Ltd., Dolbeau, Que. (*S. 1909*) (*A.M. 1914*) (*M. 1920*)

EVANS, D. E., B.Sc., (McGill '30), M.Eng. '33, Apt. 4, 1466 Mansfield St., Montreal, Que. (*S. 1930*)

EVANS, Edward A , Evans, Oliver & Tremblay, Box 175, 147 Mountain Hill, Quebec, Que. (*M. 1887*) (*Life Member*)

EVANS, Edward N., 352 Kitchener Ave., Westmount, Que. (*S. 1930*)

EVANS, Edwin George, Box 462, Sussex, N.B. (*M. 1908*) (*Life Member*)

♂EVANS, Edwin Ronald, Capt., M.C., Bldg. Supt., Parsons Construction Co. Ltd., Moncton, N B. (*H*) Lewisville, N.B. (*A.M. 1920*) (*M. 1934*)

EVANS, Geo. Ed., B.A., LL.B., (T.C.D. '81), Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 76 Lyndhurst Ave. (*A.M. 1907*)

EVANS, Maurice John, (R.M.C., Kingston '20), Dir. Gulf Logging Co. Ltd., Whaletown, B.C. Address: c/o Royal Trust Co., Victoria, B.C. (*S. 1921*) (*Jr. 1922*) (*A.M. 1932*)

EVANS, Owen Allen, B.Sc., (Queen's 33), Assayer. Mines Dept., Algoma Central Rly., Sault Ste. Marie, Ont. (*H*) 179 Denis St. (*Jr. 1934*)

EVANS, Philip N., B.Eng., (McGill '33), Can. Industries Ltd., P.O. Box 1260, Montreal, Que. (*H*) 352 Kitchener Ave., Westmount, Que. (*S. 1933*)

EVANS, Thos. Owen, B.Sc., (McGill '27), Asst. Supt., Back River Plant, Montreal Island Power Co., St. Vincent de Paul, Que. (*A.M. 1935*)

♂EWART, Cecil, Major. D.S.O., Div. Engr., C.N.R., Rm. 459, Union Depot, Winnipeg, Man. (*H*) 22 Rochester Apts., Edmonton St. (*A.M. 1907*) (*M. 1911*)

EWART, Frank Richard, B.A.Sc., (Tor. '08), Partner, Ewart, Armer & Byam, Ltd., 909 Excelsior Life Bldg., Toronto, Ont. (*H*) 165 Grenadier Rd. (*M. 1921*)

†EWART, George R., Jr., B.Sc. (McGill '00), Mgr., Cebu Sugar Co. Inc., Cebu, P.O. Box 195, Philippine Islands. (*S. 1898*) (*A.M. 1909*)

EWART, Henry Edward, Supt., Royal Canadian Mint, Ottawa, Ont. (*H*) 243 First Ave. (*M. 1935*)

EWART, J. Albert, B.A.Sc., (Tor. '95), Architect, 909 Jackson Bldg., Ottawa, Ont. (*H*) 114 Cameron St. (*A.M. 1907*)

EWENS, Frank G., B.A.Sc., (Tor. '32), Apt. 3. 83 Madison Ave., Toronto, Ont. (*S. 1932*)

♂EWING, Wm. Adam, Lieut., M.M , C.N.R., London, Ont. (*S. 1907*) (*A.M. 1915*)

FAGAN, James Wilfrid, B.Sc., (McGill '23), Asst. Gen. Supt., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4210 Marcil Ave. (*S. 1920*) (*A.M. 1930*)

FAHEY, Jas. Vincent, B.Sc., (Queen's '21), 138 James St., St. Catharines, Ont. (*Jr. 1922*) (*A.M. 1927*)

FAIRBAIRN, John Macfarlane, B.Sc., (McGill '24), Gen. Mgr., Chas. Warnock & Co., 1000 McGill Bldg., 485 McGill St , Montreal, Que. (*H*) 306 Lansdowne Ave. (*S. 1921*) (*A.M 1931*)

FAIRBAIRN, John M. R., D.Sc , (Tor. '93), Chief Engr , C.P.R., Windsor Station, Montreal, Que. (*H*) 1939 St. Luke St. (*A.M. 1899*) (*M. 1908*) (*Past President*)

FAIRBAIRN, Rhys Aikins, B.A.Sc., (Tor. '23), Divn. Comm. Superv., Bell Telephone Co. of Canada, 76 Adelaide St W., Toronto, Ont. (*H*) 43 Duggan Ave. (*S. 1921*) (*A.M. 1928*)

FAIRLIE, Howard Wallace, (Tor '10), Mgr., Delta Star Electric Co., 750 Belair Ave., Montreal, Que. (*H*) 155 Edison Ave , St. Lambert, Que. (*A.M. 1920*)

FALKNER, John Wm., Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 172 Bythwood Rd (*A.M. 1922*)

FANJOY, Wm. T., B.Sc., (Alta. '24), Indust. Control Dept., Can Gen. Elec. Co Ltd., Peterborough, Ont. (*H*) 223 Crescent St. (*S. 1925*) (*Jr. 1929*) (*Sec.-Treas., Peterborough Br., E.I.C.*)

FARMER, Eric Westover, B.Sc., (McGill '24), Elec. Engr., Can. Marconi Co., Ltd., Montreal, Que. (*H*) 35 Beverley Ave., Town of Mount Royal, Que. (*S. 1922*) (*A.M. 1928*)

G †FARMER, John Taylor, M.Sc., (Liverpool), M.A.Sc., (McGill), Mech. Engr., Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*H*) 30 Maple Ave., Ste. Anne de Bellevue, Que. (*S. 1897*) (*A.M. 1905*) (*M. 1919*)

FARMER, Rupert Whitley, B.Sc., (McGill '21), Field Engr., E. G. M. Cape & Co., Contrs., New Birks Bldg., Montreal, Que. (*H*) 135 Hillcrest Ave., Montreal West, Que. (*A.M. 1930*)

♂FARNSWORTH, Arthur Leslie, B.Sc., (McGill '23), Howard Smith Paper Mills, Cornwall, Ont (*H*) 206 Fifth St W. (*S. 1921*) (*Jr. 1925*) (*A.M 1929*)

♂FARNSWORTH, F D , City Mgr and City Engr., City Hall, City of Brewer, Maine (*H*) 39 School St (*A.M. 1923*)

♂FARNSWORTH, Raymond H., Lieut., B.Sc., (Queen's '16), Anglo-Canadian Pulp and Paper Mills, Ltd., Quebec, Que. (*H*) 454 St. Cyrille St. (*Jr. 1921*) (*A.M 1930*)

FARRAR, N., B.Sc., (McGill '25), Can. International Paper Co., 1155 Beaver Hall Hill, Montreal, Que. (*H*) 2237 Grand Blvd. (*S. 1923*) (*Jr. 1926*)

FARRELL, Alfred J., B.Sc., (McGill '24), Royal Trust Co., Montreal, Que. (*H*) 5088 Cote St. Antoine Rd. (*S. 1924*) (*Jr. 1926*)

♂FARRELL, J. W. D., Capt., B.Sc., (Queen's '15), Supt , Waterworks, City of Regina, City Hall. (*H*) 3025 Rae St , Regina, Sask. (*Jr. 1920*) (*A.M. 1921*) (*M 1935*)

♂FARROW, Richard Charles, B.C L.S., Hydr. Engr., Water Rights Br., B.C , Parliament Bldgs., Victoria, B.C. (*H*) 1633 Davie St. (*A.M. 1933*)

FAULKNER, Frederick R , B.A , (Acadia), S.B., (M.I.T.), Professor of Civil Engineering. Nova Scotia Technical College, Halifax, N.S. (*H*) 28 Fenwick St (*M 1918*)

FAURE, Marcil A., B.A.Sc., (Ecole Polytech. Montreal '34), 32 Elmwood Ave., Outremont, Que. (*S. 1934*)

FAWCETT, Sydney Dawson, D.L.S., Topographical Surveys Br., Dept. Inter., Ottawa, Ont. (*H*) 120 Belmont Ave. (*S. 1907*) (*Jr. 1915*) (*A.M. 1922*)

FAY, Frederic H., S.B., M.Sc., Fay, Spofford & Thorndike, Cons. Engrs., Waterman Bldg., 44 School St., Boston, Mass. (*H*) 227 Savin Hill Ave., Dorchester, Mass. (*M. 1909*)

FEETHAM, Luke B., B.Sc., (N.S.T.C. '21), Asst. Engr., Halifax Harbour Commrs., Halifax, N.S. (*H*) 2 Stanley Place. (*A.M. 1930*)

FEICK, C. G. E., B.A.Sc., (Tor. '28), Port Elgin, Ont. (*Jr. 1932*)

FELL, Arthur Thornton, B.A.Sc., Works Lab. Chemist, Can. Industries Ltd., McMasterville, Que. (*H*) 921 Foul Bay Rd., Victoria, B.C. (*S. 1928*)

FELLHEIMER, Alfred, B.Sc., (Illinois '95), Sr. Member firm of Alfred Fellheimer-Stewart Wagner, Arch'ts. and Engrs., 155 E. 42nd St., New York, N.Y. (*H*) 110 Riverside Drive. (*M. 1929*)

FELLOWS, Howard, B.Sc , (McGill '21), Asst. Chief Engr., Nova Scotia Power Comm., Bank of Nova Scotia Bldg., Halifax, N.S. (*H*) 247 Town Rd. (*A.M. 1930*)

FENNER, Thos. Henry, Mgr. Engrg. Dept., General Accident Assurance Co. of Canada, 357 Bay St., Toronto 2, Ont. (*H*) Apt. 1, 420 Walmer Rd. (*A.M. 1922*)

FENNIS, Albert M., c/o North American Cyanamid Co., Niagara Falls, Ont. (*A.M. 1931*)

FERGUSON, Alexander, Asst. Gen. Mgr. and Acting Comptroller, Harbour Commrs. of Montreal, 357 Common St., Montreal, Que. (*H*) 642 Murray Hill Ave., Westmount, Que. (*S. 1905*) (*A.M. 1907*) (*M. 1914*)

FERGUSON, A. A., B.Sc., (Dalhousie '29), B.Sc., (McGill '31), Reed, Shaw & McNaught, Royal Bank Bldg., Montreal, Que. (*H*) Pictou, N.S. (*S. 1929*)

♂FERGUSON, Andrew Welsh, Cadboro Bay, V.I., B.C. (*S. 1910*) (*Jr. 1914*) (*A.M. 1921*)

♂FERGUSON, Geo. Hendry, Capt., M.C., B.A.Sc., (Tor. '06), D.L.S., Chief Sanitary Engr., Dept. of Pensions and National Health, Elgin Bldg., Ottawa, Ont. (*H*) 296 Buena Vista Rd., Rockcliffe, Ont. (*S. 1906*) (*A.M. 1909*) (*M. 1919*)

FERGUSON, Hardy S., (q), B.S., C.E., Cons. Engr., Hardy S. Ferguson & Co., 200 Fifth Ave., New York, N.Y. (*M. 1903*)

♂FERGUSON, James, Lieut., Div. Engr., C.N.R., London, Ont. (*H*) 96 Windsor Ave. (*Jr. 1913*) (*A.M. 1916*)

FERGUSON, Jas. Bell, B.Sc. (McGill '35), Asst. Mgr., Pictou Foundry and Machine Co., P.O. Box 260, Pictou, N.S. (*S. 1932*)

FERGUSON, John Henry, B.Sc., (Man. '29), R.C.A.F., Dept. National Defence, 215 Canadian Bldg., Ottawa Ont. (*H*) 215 Gladstone St. (*Jr. 1931*)

FERGUSON, Robert, 67 Elmer Ave., Toronto, Ont. (*A.M. 1917*)

FERGUSON, Wm. Patterson, B.Sc., (McGill '24), Mgr., Peacock Brothers, Ltd., Pacific Coast Fire Bldg., Vancouver, B.C. (*H*) 4550–7th Ave. W. (*A.M. 1930*)

♂FERGUSSON, Hugh Boscawen, 32 St. John's Park, Blackheath, London, S.E.3. (*A.M. 1910*) (*M. 1915*)

♂FERRIER, Alan ,M.C., B.Sc., (McGill '20), Squadron-Leader, Aeronautical Engr. for Development, R.C.A.F., Dept. of National Defence, Ottawa, Ont. (*H*) 370 Driveway. (*S. 1919*) (*A.M. 1922*)

♂FETHERSTONHAUGH, Edward P., Lt.-Col., M.C., B.Sc., (McGill '99), Dean of the Faculty of Engrg. and Arch., and Prof. of Elec. Engrg., University of Manitoba, Winnipeg, Man. (*H*) 801 Dorchester Ave. (*S. 1899*) (*A.M. 1908*) (*M. 1920*)

♂FETHERSTONHAUGH, Wm. S., Lt.-Col., C.B.E., Div. Engr., C.N.R., Calgary, Alta. (*H*) 810 Royal Ave. (*A.M. 1907*) (*M. 1914*)

♂FETTERLY, Philip Austin, Lieut., B.Sc., (McGill '09), Dom. Water Power and Hydrometric Bureau, Dept. Interior, Calgary, Alta. (*H*) 639–14th Ave. W. (*Jr. 1912*) (*A.M. 1913*)

♂FIEGEHEN, Edward Geo., Major, R.E., Mech. Engr., Griswold & Co. Ltd , 407 McGill St., Montreal, Que. (*H*) Box 107, Chateauguay Basin, Que. (*M. 1928*)

FIELD, Reginald Hugh, (Liverpool '13), Superv., Physical Testing Lab., Dept. Physics and Engrg., National Research Council, Ottawa, Ont. (*H*) 12 Rockcliffe Way. (*A.M. 1922*)

♂FIFE, W. M., Lieut., B.Sc., (Alta. '13), S.M., (M.I.T.), Assoc. Prof. Massachusetts Institute of Technology, Cambridge, Mass. (*H*) 44 Lakewood Rd., Newton Highlands, Mass. (*Jr. 1914*) (*A.M. 1927*)

♂FINDLATER, Richard Hamilton, 74 Highfield St., Moncton, N.B. (*M. 1935*)

FINDLAY, Reginald Hudson, A R.T.C., Mech. Engr., Dom. Bridge Co. Ltd., Box 4016, Montreal, Que. (*H*) 266 Lansdowne Ave., Westmount, Que. (*A.M. 1920*) (*M. 1932*)

FINLAY, Ruskin Reid, B.A.Sc., (Tor. '35), 61 Breadalbane St., Toronto, Ont. (*S. 1933*)

FINLAYSON, A. W., B.Sc., (McGill '24), Committee on Newsprint, 1021 Royal Bank Bldg., Montreal. Que. (*H*) 4939 Earnscliffe Ave., (*S. 1922*) (*A.M. 1930*)

FINLAYSON, Ernest Herbert, B.Sc., (Tor. '12), Director of Forestry, Forest Service, Dept. Inter., Ottawa, Ont. (*H*) 171 Cameron St. (*A.M. 1923*) (*M. 1927*)

FINLAYSON, John N., M Sc., (McGill '09), Prof. of Civil Engrg., University of Manitoba, Winnipeg, Man., and Cons. Engr. (*H*) 271 Harvard Ave. (*S. 1908*) (*A.M. 1912*) (*M. 1919*)

FINNEMORE, Harold Forsyth, B.Sc., (Queen's '17), Asst. Elec Engr., C.N.R., 905 C.N. Express Bldg., Montreal, Que. (*H*) 112 Balfour Ave., Town of Mt. Royal, Que. (*A.M. 1921*)

FINNIE, Oswald Sterling, B.Sc., (McGill '97), D.L.S., 346 Queen St., Ottawa, Ont. (*A.M. 1912*) (*M. 1921*)

FIRTH, Angus T., Speight Specialty Co., 23 Jarvis St., Toronto, Ont. (*H*) 25 Hilda Ave. (*S. 1931*)

FISHER, Chas. B., B.Sc., (Tor. '30), Radio Engr., Dept. 159, Northern Electric Co., 1261 Shearer St., Montreal, Que. (*H*) Apt. 7, 410 Victoria Ave., Westmount, Que. (*S. 1927*)

FISHER, Fred Sorley, B.Sc., (Alta., '24), Tech. Dev. Dept., Northern Electric Co., Ltd., Dept. 865, 1261 Shearer St., Montreal, Que. (*H*) 2144 Prud'homme Ave. (*Jr. 1926*)

FISHER, John A., B.A.Sc., (Tor. '32), Mech. Sales Dept., Can. Goodrich Co., Kitchener, Ont., Box 162, Fergus, Ont. (*S. 1932*)

FISHER, Richard James, South African Iron and Steel Industrial Corp. Ltd., 82 Marshall St., Johannesburg, S.A. (*A.M. 1921*)

FISHER, Seymour J., B.Sc., (McGill '10), Gen. Supt., Price Bros. & Co. Ltd., Riverbend, Que. (*A M. 1915*) (*M. 1919*)

FISHER, Sidney Thomson, B.A.Sc., (Tor. '30), Engr., Northern Electric Co., 1261 Shearer St,. Montreal, Que. (*H*) Apt. 7, 410 Victoria Ave., Westmount, Que. (*S. 1927*) (*Jr. 1935*)

FITZGERALD, Geo. G., Superv., Manual Training, Regina School Board. (*H*) 2321 Garnet St., Regina, Sask (*A.M. 1924*)

FITZ-JAMES, H. C., Vice-Pres. and Mgr., Pacific Coast Pipe Co., 1551 Granville St., Vancouver, B.C. (*H*) 2090 S.W. Marine Drive. (*A.M. 1919*)

FLAHERTY, B. G., B.S., (Washington '16), Chief Engr., General Dredging Contractors, Ltd., 1405 Peel St., Montreal, Que. (*H*) 6657 Monkland Ave. (*M. 1932*)

FLANAGAN, Oliver L., B.A.Sc., (Tor. '10), 921 St. Clair Ave. W., Toronto, Out. (*A.M. 1913*)

FLAY, William H. G., Br. Mgr., Dom. Reinforcing Steel Co., 396 Somerset St. W., Ottawa, Ont. (*H*) 386 Sunnyside Ave. (*A.M. 1921*)

♂FLEISCHMANN, Albert Chas., 3271 Van Horne Ave., Montreal, Que. (*A.M 1928*)

*P.*FLEMING, Alex. Greig, B.A., (Queen's '04), Chief Chemist, Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. (*H*) 2105 Grey Ave. (*M. 1928*)

FLEMING, C. D., B.Sc., (McGill '24), Anglin-Norcross Ontario Ltd., 57 Bloor St. W., Toronto, Ont. (*H*) 66 Rathnelly Ave. (*S. 1924*) (*Jr. 1928*) (*A.M. 1932*)

FLEMING, Donald C., B.Sc., (Alta. '33), 511-17th Ave. W., Calgary, Alta. (*S. 1933*)

FLEMING, John M., B.Sc., (Man. '21), Str'l. Designer, C. D. Howe & Co., 710 Whalen Bldg., Port Arthur, Ont. (*H*) 114 Prospect Ave. (*S. 1919*) (*A.M. 1928*)

♂FLEMING, Robert, C.E., Vice-Pres., Wood, Fleming & Co., 700 Royal Bank Bldg., Toronto, Ont. (*H*) 61 Foxbar Rd. (*M. 1921*)

♂FLETCHER, Hugh Murray, Lieut., (Tor. '06), 377 Hess St. S., Hamilton, Ont. (*A.M. 1922*)

FLETCHER, Thos. H., B.Sc. (N.B. '34), Coles Island, Queens County, N.B. (*S. 1934*)

♂FLETCHER, W. J., Lieut., B.Sc., (Queen's '10), O.L.S., Private Practice, 201 Security Bldg., Windsor, Ont. (*H*) 147 Partington Ave. (*A.M. 1919*)

FLEURY, J. Ernest, B.A., C.E., (Ecole Polytech., Montreal '17), Asst. Principal, Technical and Papermaking School, 7-A Ste. Marie St., Three Rivers, Que. (*A.M. 1927*)

FLEURY, Maurice, B.A.Sc., (Ecole Polytech. Montreal '34), Agent, Industrial Scientific Apparatus Co. Ltd., 521 Ontario St. E., Montreal, Que. (*H*) 40 Spring Grove, Outremont, Que. (*S. 1934*)

FLEXMAN, J. K., B.Sc., (Queen's '33), Lt. R.C.E., c/o The S.M.E., Brompton Barracks, Chatham, Kent, England. (*S. 1933*)

FLINTOFF, Allan F., B.Sc., Asst. Res. Engr., Dept. of Highways, Stratford, Ont. (*H*) 90 Front St. (*Jr. 1932*)

FLITTON, Ralph Cyril, B.Sc., (McGill '14), Engr., Wm. Hamilton Divn., Can. Vickers, Ltd., Box 550, Montreal. Que. (*H*) 4867 Wilson Ave., N.D.G. (*Jr. 1914*) (*A.M. 1920*)

FLOOD, John N., B.Sc., (N.B. '16), Pres., John Flood & Sons, Ltd., 111 Princess St., Saint John, N.B. (*H*) 96 Coburg St. (*Jr. 1920*) (*A.M. 1923*)

FOGARTY, J. William P., B.Sc., (McGill '31), Instr. in Physics, St. Francis Xavier University, Antigonish, N.S. (*H*) 124 Weldon St., Moncton, N.B (*S. 1929*)

FOGARTY, Orville Alden, Mgr., Oil Burners Divn., Can. Fairbanks-Morse Co., Montreal, Que. (*H*) 2178 Old Orchard Ave. (*M. 1922*)

FONG, W. H., B.Sc., (McGill '28), 123 Dorchester St. W., Montreal, Que. (*S. 1926*)

FORBES, Jas. MacGregor, Res. Engr., Highways Br., Dept. P.W., Alta., Edmonton, Alta. (*H*) 10547-125th St. (*A.M. 1920*)

♂FORBES, John Hunter, Major, B.Sc., (McGill '08), Asst. Dist. Engr., C.P.R., Montreal, Que. (*H*) 420 Wiseman Ave., Outremont, Que. (*A.M. 1919*)

FORD, Arthur L., B.A.Sc., (Tor. '05), R.R. 1, Royal Oak, Saanich, V.I., B.C. (*A.M. 1908*) (*M. 1914*)

FORD, J. William H., B.A.Sc., (Tor. '15), Supt., Shawinigan Engineering Co. Ltd., Power Bldg., Montreal, Que. (*H*) Apt. 5, 1154 St. Mark St., Montreal, Que. (*S. 1911*) (*Jr. 1916*) (*A.M. 1919*)

♂FORD, Robert, B.Sc., (McGill '22), Plant Engr., Dom. Rubber Co. Ltd., Papineau Factory, Montreal, Que. (*H*) Apt. 3, Sherbrooke Apts., 1374 Sherbrooke St. W. (*S. 1921*) (*Jr. 1923*) (*A.M. 1925*)

FORD, William B., O.L.S., Can. Engineering and Contracting Co. Ltd., 506 Imperial Bldg., Hamilton, Ont. (*H*) 42 Ontario St., Burlington, Ont. (*A.M. 1899*) (*Life Member*)

†FORDE, John Preston, Dist. Engr., D.P.W., Canada, 319 P.O. Bldg., Victoria, B.C. (*H*) 2160 Sperling St. (*M. 1905*)

FORD-SMITH, Percy, Pres. and Gen. Mgr., The Ford-Smith Machine Co. Ltd., Hamilton, Ont. (*H*) Ancaster, Ont. (*A.M. 1928*) (*M. 1930*)

†FOREMAN, Alvah E., B.Sc., (McGill '03), Assoc. Prof. of C.E., University of B.C., Unversity Hill, Vancouver, B.C. (*H*) 4553-W. 8th Ave. (*S. 1903*) (*A.M. 1909*) (*M. 1918*)

♂FOREMAN, John Leonard, Lieut., B.A.Sc., (Tor. '14), Officer i/c Lake Winnipeg Surveys, Hydrographic Survey, Dept. of Marine, Ottawa, Ont. (*H*) 587 MacLaren St. (*S. 1914*) (*A.M. 1921*)

♂FORGAN, David, Capt., Constrn. Engr., H.E.P.C. Ont., 620 University Ave., Tornto, Ont. (*H*) Highland Cres., R.R. 2, York Mills, Ont. (*A.M. 1932*)

FORGIE, James, Cons. Engr., 15 William St., New York, N.Y. (*M. 1910*)

FORRISTAL, Gerald Jos., Asst. Mgr., London & Petrolia Barrel Co., Ltd., 763 Little Simcoe St., Loudon, Ont. (*H*) 562 Wellington St. (*S. 1927*)

FORSBERG, C. R., B.Sc., (Sask. '31), Dunblane, Sask. (*S. 1931*)

FORTIN, Eugene, 13 Ste. Anne, Pointe-aux-Trembles, Que. (*A.M. 1923*)

FORTIN, J. Joachim, 3567 Papineau Ave., Montreal, Que. (*S. 1908*) (*A.M. 1913*)

FORTIN, Jean Julien, B.Sc., (Queen's '34), Elec. Engr., Saguenay Power Co. Ltd., Arvida, Que. (*H*) 48 Ave. Begin, Chicoutimi, Que. (*Jr. 1935*)

FORTIN, Sifroy Joseph, Cons. Engr. to Executive Committee, City of Montreal, City Hall, Montreal, Que. (*H*) 3800 Grey Ave. (*M. 1915*)

FORWARD, Edwin Albert, (Tor. '97), Chief Engr., Angus Robertson Ltd., Rm. 1406, 1440 St. Catherine St. W., Montreal, Que. (*H*) 3567 Durocher St. (*A.M. 1900*) (*M. 1911*)

FORWARD, Frank A., B.A.Sc., (Tor. '24), University of B.C., Vancouver, B.C. (*S. 1921*) (*Jr. 1929*)

†FOSNESS, Arthur Williams, E.M., (Minn. '11), Chief Engr., Carter-Halls Aldinger Co., 515 Union Bank Bldg., Winnipeg, Man. (*A.M. 1921*) (*M. 1927*)

FOSS, Carroll Lund, P.L.S., Wilmot, Annapolis Co., N.S. (*A.M. 1920*)

FOSTER, Vernon Simons, B.Sc., (Kansas '10), M.Sc., (Penn. State '16), Induction Motor Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 510 Gilmour St. (*A.M. 1920*)

FOULIS, A. D., B.Sc., (N.S.T.C. '29), Sales Engr., Can. Fairbanks Morse Co. Ltd., 164-66 Granville St., Halifax, N.S. (*H*) 40 Walnut St. (*Jr. 1931*)

FOULKES, Thos., B.Sc., (N.B. '26), Asst. Mtce. Supt., Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*H*) Campbellton, N.B. (*S. 1925*) (*Jr. 1929*)

FOURNIER, Victor A., B.A., (Laval '11), 860 Dunlop Ave., Outremont, Que. (*S. 1913*) (*A.M. 1923*)

FOWLER, C. A. DeW., B.Sc., (N.S.T.C. '14), C. A. Fowler & Co., Engrs. and Arch'ts., Capitol Bldg., Halifax, N.S. (*H*) 67 Norwood St. (*A.M. 1919*) (*M. 1923*)

FOWLER, Charles E., M.Sc., Cons. Engr., 5 West 63rd St., New York, N.Y. (*M. 1904*)

♂FOWLER, Frank Scott, Capt., M.C., B.Sc., (McGill '10), Dir., Nelson River Construction Co. Ltd., 607 Union Trust Bldg., Winnipeg, Man. (*A.M. 1915*)

♂FOX, C. Harry, Lieut., M.Sc., (McGill '10), Engr. of Water Service, C.P.R., Winnipeg, Man. (*H*) Royal Alexandra Hotel. (*S. 1907*) (*A.M. 1913*) (*M. 1921*)

FOX, John Holloway, B.A.Sc., (Tor. '27), Engr., Minneapolis Honeywell Regulator Co. Ltd., 117 Peter St., Toronto, Ont. (*H*) 37 Macdonell Ave. (*S. 1926*) (*Jr. 1930*) (*A.M. 1935*)

FOY, Albert J. B., B.Sc., (McGill '24), Inspr., Can. Fire Underwriters Assn., 628 Coristine Bldg., Montreal, Que. (*H*) 71 Clandeboye Ave., Westmount, Que. (*S. 1925*) (*A.M. 1931*)

FRAME, Stanley H., Hydraulic Engr., Water Rights Br., Dept. of Lands, Parliament Bldgs., Victoria, B.C. (*S. 1903*) (*A.M. 1911*)

FRANCIS, John Barton, B.Sc., (McGill '30), Can. Industries Ltd., Montreal, Que. (*H*) 4100 Cote des Neiges Rd. (*S. 1928*)

♂FRANCIS, Thos. Frederick, Lieut., Apt. 2, 8 Dundonald St., Toronto, Ont. (*A.M. 1920*)

FRANKLIN, R. Laurence, B.Sc., (Queen's '30), Ord. Mech. Engr., R.C.O.C., Dept. of National Defence. Address: c/o Canada House, Trafalgar Sq., London, S.W.1, England. (*H*) Maxville, Ont., Canada. (*S. 1928*) (*Jr. 1934*)

FRASER, Allan D., B.Eng., (McGill '34), Siscoe Gold Mines, Ltd., Siscoe, Que. (*H*) 1239 Van Horne Ave., Montreal, Que. (*S. 1934*)

♂FRASER, Andrew S., Lieut., B.Sc., (McGill '22), Supt., Canada Starch Co., Cardinal, Ont. (*A.M. 1925*)

♂FRASER, Archibald N., Lieut., B.Sc., (McGill '09), Chief Engr., Radio Br., Dept. of Marine, Ottawa, Ont. (*H*) 11 Rockcliffe Way. (*A.M. 1926*)

♂FRASER, Arthur, Capt., (R.I.E.C. '96), c/o Sir John G. Fraser, C.M.G., P.O. Box 17, Launceston, Tasmania, Australia. (*A.M. 1921*)

FRASER, Campbell, (Dalhousie '32), B.Sc., (Queen's '34), Inspr., Dept. of Highways, Port Hope, Ont. (*S. 1930*)

FRASER, Charles E., B.Sc., (McGill '99), Pres., Fraser, Brace & Co., Inc., 10 East 40th St., New York, N.Y., and Fraser-Brace Engineering Co., 107 Craig St. W., Montreal, Que. (*H*) 83-26 Abingdon Rd., Kew Gardens, L.I., N.Y. (*S. 1899*) (*M. 1909*)

♂FRASER, Christopher Edwin, Capt., B.Sc., (Queen's '16), Engr., McNamara Construction Co. Ltd., 53 Yonge St., Toronto 2, Ont. (*H*) 78 Falcon St (*S. 1916*) (*Jr. 1920*) (*A.M. 1922*)

FRASER, Daniel Macfarlane, Pres. and Gen. Mgr., D. M. Fraser, Ltd., and Leland Electric Canada, Ltd., 9 Duke St., Toronto, Ont. (*H*) 82 Hillsdale Ave. W. (*M. 1920*)

♂FRASER, I. Matheson, B.Sc., (McGill '19), Prof., Mech. Engrg., University of Saskatchewan, Saskatoon, Sask. (*H*) 115 Albert Ave. (*Jr. 1920*) (*A.M. 1928*)

FRASER, J. Douglas, B.Sc., (Dalhousie), B.Sc., (McGill '25), Chief Engr., Acadia Sugar Refinery Co. Ltd., Box 400, Dartmouth, N.S. (*S. 1925*) (*Jr. 1929*) (*A.M. 1930*)

FRASER, John Philip, B.E.E., (Man. '14), Brandon Gen. Mgr., Manitoba Power Comm., Brandon, Man. (*H*) 247-14th St. (*A.M. 1929*)

FRASER, N. Innes, (R.M.C., Kingston), B.Sc., (McGill '30), Capt., R.C.E., D.E.O., M.D. 12, Regina, Sask. (*H*) 2824 Regina Ave. (*S. 1930*)

FRASER, Ralph Percy, B.Sc., (Man. '31), 107 Tache Ave., Norwood, Man. (*S. 1930*)

FRASER, T. Bryant, New Liskeard, Ont. (*S. 1922*)

FRASER, Willard Bruce, B.Sc., (McGill '27), Engrg. Dept., Canadian Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4369 Melrose Ave., N.D.G. (*S. 1925*) (*A.M. 1932*)

FRECKER, Geo. Alain, B.Sc., (N.S.T.C. '32), Research Asst., Dept. of Education, St. John's, Nfld. (*H*) Maxse St., Bungalow. (*S. 1930*) (*Jr. 1934*)

FREELAND, John Anderson, B.Sc., (Penna. '03), Cons. Paper Corp., Ltd., Montreal, Que. (*H*) 2425 Madison Ave., N.D.G. (*A.M. 1908*)

FREELAND, John James, B.Sc., (McGill '15), Can. International Paper Co., Temiskaming, Que. (*A.M. 1927*)

FREEMAN, Charles B., Sec.-Treas., Orchardson & Co., Ltd., 325 Howe St., Vancouver, B.C. (*H*) 5379 Elm St. (*A.M. 1910*)

FREEMAN, Geo. Leonard, B.S., (Maine '03), Member of Firm, Moran & Proctor, Cons. Engrs., 120 E. 41st St., New York, N.Y. (*H*) 335 Rich Ave., Mt. Vernon, N.Y. (*M. 1920*)

FREEMAN, J. Reginald, Sr. Asst. Engr., D.P.W., Canada, P.O. Drawer 1417, Saint John, N.B. (*H*) 58 Orange St. (*S. 1904*) (*A.M. 1910*) (*M. 1918*)

♂FREEMAN, James Roy, B.A.Sc., (Tor. '12), Asst. Engr., Chief Engr.'s Office, C.N.R., Moncton, N.B. (*H*) 112 Mountain Rd. (*A.M. 1921*)

FREEMAN, Philip A., Mech. Supt., Steam Dept., N.S. Light and Power Co., Halifax, N.S. (*H*) 8 Fawson St. (*M. 1915*)

♂FREEMAN, Robert P., Lieut., B.Sc., (N.S.T.C. '15), 3 Blueridge Apts., 4155 Cote des Neiges Rd., Montreal, Que. (*A.M. 1919*)

FREGEAU, John Henry, B.Sc., (McGill '10), Mgr., North Divn. Comm. and Distribution Dept., Shawinigan Water and Power Co., Three Rivers, Que. (*H*) 669 Notre Dame St. (*A.M. 1928*)

G.†FRENCH, Roger DeLand, B.Sc., C.E., (Worcester), Prof. of Highway and Municipal Engrg., McGill University, Montreal, Que., and Cons. Engr. (*H*) 456 Pine Ave. W. (*A.M. 1913*) (*M. 1918*)

FRENCH, Philip B., B.Eng., (McGill '34), Sales Engr., Can. S.K.F. Co. Ltd., 1075 Beaver Hall Hill, Montreal, Que. (*H*) 456 Pine Ave. W. (*S. 1934*)

♂FRIEDMAN, Ferdinand J., B.Sc., (M.I.T. '08), McDougall & Friedman, Cons. Engrs., 1221 Osborne St., Montreal, Que. (*H*) 3485 Atwater Ave. (*A.M. 1920*) (*M. 1923*)

FRIGON, A., D.Sc., (Paris), B.Sc., Dir. Gen., Technical Education, Prov. Quebec; Dean, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*H*) 125 Pagnuelo, Outremont, Que. (*S. 1907*) (*A.M. 1913*) (*M. 1931*) (*Member of Council, E.I.C.*)

FRIGON, Rosario, 169 Sherbrooke St E., Montreal, Que. (*S. 1935*)

FRIPP, Fred. Bowles, 101 Alma St., Moncton, N.B. (*A.M. 1892*) (*Life Member*)

FRISKEN, O. J., B.Sc., (Queen's '29), Sales Engr., Babcock-Wilcox & Goldie McCulloch, Ltd., 67 Yonge St., Toronto, Ont. (*H*) 181½ Bingham Ave. (*S. 1928*)

FRITH, Hugh W., Chief Engr., Vancouver Harbour Comm'rs., 712 Pender St W., Vancouver, B.C. (*H*) 5042 Pine Crescent. (*A.M. 1919*) (*M. 1925*)

FRITH, John R., B.Sc., (McGill '27), Mgr, Empire Coal Co. Ltd., 1004 Royal Bank Bldg., Toronto, Ont. (*H*) 126 Chaplin Cres. (*Jr. 1930*)

FRIZZLE, H. R., B.Sc., (N.S.T.C. '33), Berwick, King's Co., N.S. (*S. 1935*)

FRY, Albert Edward, Mech. Engr., Dom. Glass Co. Ltd., Montreal, Que. (*H*) 37 Dufferin Rd., Hampstead, Que. (*A.M. 1928*)

FRY, J. D., B.Sc., (McGill '22), Asst., McDougall & Friedman, 1221 Osborne St., Montreal, Que. (*H*) 16 Thornhill Ave., Westmount, Que (*S. 1919*) (*Jr. 1924*) (*A.M. 1934*)

FULLER, Allan F. S., B.Sc., (Sask. '33), 2315 Smith St., Regina, Sask. (*Jr. 1934*)

FULLER, Harold Paul, Asst. Engr., C.N.R., Box 446, The Pas, Man. (*A.M. 1919*)

FULLER, Royden John, B.A.Sc., (Tor. '12), Private Practice, Str'l. Engr., 243 Confederation Life Bldg., Toronto, Ont. (*H*) 399 St. Clements Ave. (*A.M. 1921*)

FULLERTON, Chas. H., (Tor. '00), O.L.S., D.L.S., Surveyor-General of Ontario, Parliament Bldgs., Toronto, Ont. (*H*) 74 Normandy Blvd. (*A.M. 1907*)

FULLERTON, Roland M., B.Sc., (N.S.T.C. '33), Shawkey Gold Mines Co. Ltd., Siscoe, Que. (*H*) 108 King St., Truro, N.S. (*S. 1931*)

FULTON, Fraser F., B.Sc., (McGill '28), Install. Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 452 Stanstead Rd., Town of Mt. Royal, Que. (*S. 1923*) (*A.M. 1934*)

♂FULTON, William, Dist. Engr., Reclam. Br., D.P.W., Winnipeg, Man (*H*) 148 Lawndale Ave., Norwood, Man. (*A.M. 1920*)

♂FULTZ, Stephen Lloyd, B.Sc., (N.S.T.C. '20), Constrn. Engr., N.S. Power Comm., Liverpool, N.S. (*H*) 64 Cedar St., Halifax, N.S. (*S. 1919*) (*Jr. 1922*) (*A.M. 1926*)

FURLONG, Henry Walter, B.Sc., (London '08), c/o Sir Alexander Gibb and Partners, Queen Anne Lodge, Westminster S.W.1, London, England. (*A.M. 1924*)

FUSEY, L. Ernest F., 10642 Grande Allee, Ahuntsic, Montreal, Que. (*A.M. 1899*) (*Life Member*)

FYFE, Herbert Dixon, (Tor. '11), Plant Engr., River Rd. Plant, Semet Solway Co., Buffalo, N.Y. (*H*) 15 Tacoma Ave. (*Jr. 1912*) (*A.M. 1920*)

♂FYFE, Robert John, Lieut., Mgr., R. J. Fyfe, Ltd., 618 Broder Bldg., Regina, Sask. (*H*) 21 Angus Cres. (*A.M. 1930*)

FYSHE, Thos. Maxwell, B.Sc., (McGill '05), Private Practice, Rm. 37, 388 St. James St. W., Montreal, Que. (*H*) 2944 Viewmount Ave. (*M. 1935*)

GABY, Frederick A., D.Sc., B.A.Sc., M.E., (Tor. '04), Asst. to the President, C.P.R., Rm. 800, 8th Floor, Windsor Station, Montreal, Que. (*H*) 480 Spadina Rd., Toronto, Ont. (*M. 1919*) (*President, E.I.C., 1935*)

GAGE, E. V., B.Sc., (McGill '15), Supt., A. F. Byers Co. Ltd., 1226 University St., Montreal, Que. (*H*) 5600 Queen Mary Rd. (*S. 1914*) (*A.M. 1919*)

GAGE, Ramsay Gray, B.Sc., (Queen's '05), Chief Elec'l. Engr., C.N.R., Rm. 702, C.N. Express Bldg., Montreal, Que. (*H*) Apt. 14, 2054 Sherbrooke St. W., Montreal, Que. (*M. 1920*)

GAGNON, Elmore G., B.Sc., (McGill '28), Comm. Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1045 Mount Royal Blvd., Outremont, Que. (*S. 1925*)

GAGNON, Ludger, B.A.Sc., (Ecole Polytech., Montreal '27), S.B., (M.I.T. '28), Asst. City Engr., City of Quebec, Quebec, Que. (*A.M. 1935*)

GAHAN, Hugh N., Dftsman., P.W. Dept. B.C., Parliament Bldgs., Victoria, B.C. (*H*) 265 Moss St. (*A.M. 1909*)

♂GAHERTY, Geoffrey Abbot, Capt., B.E., (Dalhousie '09), Pres., Montreal Engineering Co. Ltd., 244 St. James St. W., Montreal, Que. (*H*) 3957 Ramezay Ave (*A.M. 1921*) (*M. 1934*)

GALE, Alfred Valiant, Vice-Pres. and Gen. Mgr., Hull Electric Co. Ltd., 117 Main St., Hull, Que., and Gatineau Bus Co. (*H*) 15 Slater St., Ottawa, Ont. (*A.M 1916*)

GALE, George Gordon, M.Sc., (McGill '05), Pres., Gatineau Power Co., 140 Wellington St., P.O. Box 657, Ottawa, Ont. (*H*) 385 Laurier Ave. E. (*A.M. 1908*) (*M. 1916*)

GALE, Melvin Lambeth, B.Sc., (Alta. '27), Assessor, Dept. of Municipal Affairs, Alta. (*H*) 9914-111th St., Edmonton, Alta. (*A.M. 1935*)

GALEA, Arthur Fred., Arch. and L.S., 114 Strada Santa Lucia, Valletta, Malta (*A.M. 1921*)

GALILEE, J. A. M., Asst. Adv. Mgr., Can. Westinghouse Co., Hamilton, Ont. (*H*) 5 Rockwood Place. (*Affil. 1930*)

GALLER, Leo, C.E., (Vienna '17), Constrn. Supt., The Atlas Construction Co., Ltd., 679 Belmont St., Montreal, Que. (*H*) 5209 Ponsard Ave. (*A.M. 1927*)

GALLETLY, Jas. Simpson, B.A.Sc., (Tor. '11), D.L.S., Engr., R. H. McGregor Construction Co., 280 Sammon Ave., Toronto 6, Ont. (*H*) 107-27th St., Long Branch, Ont. (*A.M 1918*)

♂GAMBLE, Clarke William, Lieut., B.Sc., (McGill '07), Cons. Engr., Union Club, Victoria, B.C. (*H*) R.M.D. 1, Saanichton, V.I., B.C. (*S. 1906*) (*A.M 1909*) (*M. 1928*)

GAMBLE, Samuel Gill, (R.M.C. Kingston '32), B.Eng., (McGill '33), 269 Somerset St. W., Ottawa, Ont. (*S. 1933*)

GARDNER, Albert Chas., Dist. Engr., D.P.W., Parliament Bldgs., Court House, Medicine Hat, Alta. (*A.M. 1922*)

♂GARDNER, Wm. McG, B.Sc., (McGill '17), Supt., Constrn. and Mtce., Montreal Tramways Co., Tramways Bldg., 159 Craig St. W., Montreal, Que. (*H*) 313 Grosvenor Ave., Westmount, Que. (*S. 1916*) (*Jr. 1919*) (*A.M. 1923*)

GAREY, John Dennis, Chief Engr., N.B. Power Co., Saint John, N.B. (*H*) 401 Douglas Ave (*A.M. 1924*)

♂GARNER, Albert Coleman, Col., D.S.O., V.D., D.L.S., S.L.S., A.L.S., Chief Surveyor, Prov. Sask., Land Title Office, Regina, Sask. (*H*) 2133 Cameron St. (*S. 1094*) (*A.M. 1908*) (*M. 1916*)

♂GARNETT, Chas. Ernest, Lieut., Vice-Pres., Gorman's Ltd., Box 369, Edmonton, Alta. (*H*) 10344-132nd St. (*A.M. 1931*)

GARRETT, Julian, A.B., (Harvard '04), Mgr. and Sec.-Treas., Northwestern Utilities Ltd., 10124-104th St., Edmonton, Alta. (*H*) 10408 Park Rd. (*A.M. 1907*) (*M. 1935*)

♂GARRETT, R. W., Capt., Asst. City Engr., City of London, City Hall, London, Ont. (*H*) 77 Thornton Ave. (*A.M. 1923*)

GARVOCK, Alex. Graham, B.Eng., (McGill '33), 136 Lewis St., Ottawa, Ont. (*S. 1933*)

GASKILL, Frank, Sales Engr., Industrial Engineering Co., 58 Wellington St. E., Toronto, Ont. (*A.M. 1908*)

GATES, Archie B., B.Sc., (Queen's '11), Gen. Engr., Can Gen. Elec. Co., Peterborough, Ont. (*H*) 307 Margaret Ave. (*A.M. 1919*)

GATES, Grant Gordon, Constrn. Engr., Steel Co. of Canada, Ltd., Hamilton, Ont. (*H*) 198 Fairleigh Ave. S. (*Jr. 1922*)

GATHERCOLE, John Wm., B.Sc., (Queen's '27), Steam Plant Engr., Price Bros. & Co. Ltd., Box 103, Kenogami, Que. (*S. 1927*) (*Jr. 1931*)

GAUDEFROY, Henri, B.A.Sc., (Ecole Polytech. Montreal '33), S.B., (M.I.T '34), Elec. Engr., Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 4590 Hutchison St. (*Jr. 1934*)

♂GAUDET, Frederick Mondelet, Col., C.M.G., (R.M.C. Kingston), 1455 Drummond St., Montreal, Que. (*M. 1903*)

GAUER, Edward, B.Sc., (Man. '26), Asst Locating Engr., Good Rds. Bd., Winnipeg, Man. (*H*) 275 Evanson St. (*S. 1924*)

GAUTHIER, Paul Gilles, B.Sc., (McGill '21), Q.L.S., 660 de l'Epee Ave., Outremont, Que. (*S. 1919*) (*Jr. 1922*) (*A.M. 1928*)

GAUVIN, Hervé A., B.Sc., (Sask. '22), B.Sc., (McGill '26), Divn. Engr., Prov. Dept. of Roads, L'Assomption, Que. (*S. 1925*) (*Jr. 1928*)

♂GAYFER, Arthur John, Major, C.N.R. (*H*) 9917-108th St., Edmonton, Alta. (*A.M. 1905*) (*M. 1916*)

GAYFER, Edwin Ralph, B.Sc., (Man. '33), 9917-108th St., Edmonton, Alta. (*S. 1934*)

♂GEALE, Chas. Norman, Capt., B.A.Sc., (Tor. '15), Asst. Supt., Southern Divn., Welland Ship Canal, Port Colborne, Ont. (*S. 1915*) (*A.M. 1930*)

GEIGER, D. G., B.Sc., (Queen's '22), Trans. Engr., W.A., Bell Telephone Co., of Canada, Canada Permanent Bldg., Toronto, Ont. (*H*) 27 Austin Terrace. (*S. 1922*) (*A.M. 1928*)

GELDARD, P. W., B.A.Sc., (Tor. '29), Supt., Street Dept., Consumers Gas Co., 19 Toronto St., Toronto, Ont., (*H*) 93 Boon Ave. (*Jr. 1928*) (*A.M. 1932*)

GENDERS, Percy Robert, Examiner, Surveys Branch, Land Titles Office, Regina, Sask. (*H*) 2243 Albert St. (*A.M. 1917*)

GENIK, Alex., B.Sc., (Man. '27), Asst. Engr., The Bell Telephone Co. of Canada, Toronto, Ont. (*H*) 69 High Park Blvd. (*S. 1927*)

GENTLES, Allan Summerhayes, B.Sc., (McGill '14), Mgr., Pacific Divn., Dom. Bridge Co. Ltd., 275 First Ave. W., Vancouver, B.C. (*H*) Caulfield P.O., W. Vancouver, B.C. (*M. 1930*)

GERIN, Maurice, B.Sc., (Montreal '20), M.Sc., (M.I.T. '21), Dept. Mgr., Can. Fairbanks-Morse Co., 980 St. Antoine St., Montreal, Que. (*H*) 5569 Darlington Ave. (*Jr. 1923*) (*A.M. 1932*)

♂GERMAN, Alan Macdonnell, Capt., B.A.Sc., (Tor. '14), Asst. Mgr. and Gen. Supt., Can. Dredging Co. Ltd., 302 Harbour Commission Bldg., Toronto, Ont. (*M. 1934*)

♂GEROW, Carlyle, B.Sc., (Queen's '22), Asst. Gen. Mgr., Coal Sales, Dom. Steel and Coal Corp., Ltd., 624 Canada Cement Bldg., Montreal, Que. (*H*) 4384 Coolbrook Ave. (*A.M. 1931*)

GERSOVITZ, Frank, B.Eng., (McGill '32), 457 Argyle Ave., Westmount, Que. (*S. 1930*)

♂GIBB, Sir Alexander, G.B.E., C.B., Chartered C.E., Sir Alexander Gibb & Partners, Queen Anne's Lodge, Westminster, London, S.W.1, England. (*H*) Tangier Park, nr. Basingstoke, Hants. (*M. 1932*)

♂GIBB, Hugh M., Major, Balfour Beatty & Co. Ltd., 66 Queen St., London, E.C.4. (*H*) 49 Watling St., London, E.C.4. (*A.M. 1910*)

GIBB, Robert J., Asst. City Engr. and Supt. Waterworks, Edmonton, Alta. (*H*) 9837-93rd Ave., Edmonton South, Alta. (*A.M. 1910*) (*M. 1914*)

GIBBON, H. S. V., Fld. Engr., The Bell Telephone Co. of Canada, 335 Catherine St., Ottawa, Ont. (*H*) 947 Bronson Ave. (*Jr. 1927*)

GIBBONS, Jas. Fenton, B.Sc., (N.B. '35), Kingston Peninsula Telephone Co., Baywater, N.B. (*S. 1935*)

GIBBS, C. R., B.Sc., (McGill '16), Supt. of Mtce., Kalamazoo Vegetable Parchment Co., Parchment, Mich. (*H*) 295 Glendale Blvd (*S. 1914*) (*A.M. 1927*)

GIBEAU, Henri Adelard, C.E., (Renss. '08), Asst. Director, P.W., City of Montreal, Que. (*H*) 2350 Sherbrooke St. E. (*A.M. 1915*)

GIBSON, Alfred, B.A.Sc., (Tor. '03), Kilmer & Barber, 10 Adelaide St. E., Toronto, Ont. (*A.M. 1906*)

♂GIBSON, John McI., Lt.-Col., D.S.O., B.A.Sc., (Tor. '10), Private Practice (Str'l.), 154 Wright Ave., Toronto, Ont. (*Jr. 1914*) (*A.M. 1919*)

†GIBSON, Norman R., D.Eng., B.A.Sc., (Tor. '04), Vice-Pres. and Chief Engr., Buffalo, Niagara & Eastern Power Corp., 600 Electric Bldg., Buffalo, N.Y. (*H*) Mountain View Drive, Lewiston Heights, Lewiston, N.Y. (*A.M. 1907*) (*M. 1921*)

♂GIFFORD, F. Darrell, Major, M.C., Res. Engr., Dept. of Northern Development, New Liskeard, Ont. (*Jr. 1922*) (*A.M. 1927*)

♂GILBERT, Edgar V., B.Sc., (McGill '23), 263 Holmwood Ave., Ottawa, Ont. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

♂GILBERT, Gordon McD., B.Sc., (Man. '26), A/Engr. and Supt., Vancouver and District Joint Sewerage and Drainage Bd., 1204 Bekins Bldg., Vancouver, B.C. (*A.M. 1934*) (*M. 1935*) (*Sec.-Treas., Vancouver Br., E.I.C.*)

GILCHRIST, John, B.Sc., (N.B. '32), General Steel Wares, Delisle St., Montreal, Que. (*H*) 6 Weredale Park, Westmount, Que. (*Jr. 1934*)

GILCHRIST, T. E., B.Sc., (McGill '10), Works Engrg. Dept., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 317 Elias Ave. (*A.M. 1919*)

GILDEA, W. F. P., Brownville Jct., Maine, U.S.A. (*S. 1935*)

GILES, B. H. D., B.Sc., (McGill '27), Can. S.K.F. Co. Ltd., 1101 Beaver Hall Hill, Montreal, Que. (*Jr. 1929*)

♂GILL, L. W., Lt.-Col., M.Sc., Principal, Hamilton Technical Institute, Hamilton, Ont. (*H*) Waterdown, Ont. (*A.M. 1901*) (*M. 1912*)

GILLETT, Geo. Herbert, B.Sc., (McGill '24), Sales Engr., Can. Gen. Elec. Co. Ltd., Beaver Hall Hill, Montreal, Que. (*H*) 4720 Westmount Blvd., Westmount, Que. (*S. 1924*)

GILLETZ, Colly, 5206 Trans Island Ave., Montreal, Que. (*S. 1924*)

GILMORE, Ross Earlby, B.A., M.A., (McMaster '13), M.Sc., (Illinois '16), Supt., Fuel Research Lab., Mines Branch, Dept. of Mines, 562 Booth St., Ottawa, Ont. (*H*) 334 First Ave. (*M. 1926*)

GILMOUR, W. A. T., B.Sc., (McGill '26), Sales Engr., Smart-Turner Machine Co. Ltd., Hamilton, Ont. (*H*) 49 St. James Place. (*S. 1924*) (*Jr. 1930*)

GIRDWOOD, Arthur J., B.A.Sc., (Tor. '34), Engr., Can Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 551 King St. (*S. 1931*)

GISBORNE, Hartley, 288 E. 23rd Ave., Vancouver, B.C. (*A.M. 1887*) (*M. 1892*) (*Life Member*)

GISBORNE, Lionel L., B.Sc., (McGill '99), Works Supt., Niagara Parks Comm., Queen Victoria Park, Niagara Falls, Ont. (*H*) 1811 Prince Edward Ave. (*A.M. 1919*)

GLIDDON, W. G. C., B.Sc., (McGill '21), M.Sc., '22, Chief Engr., Gatineau Power Co., Ottawa, Ont. (*H*) 430 Nelson St. (*A.M. 1930*)

♂GLOVER, Thos. Stanley, Lieut., M.C., B.A.Sc., (Tor. '22), Account Exec., Indust. Adv., Russell T. Kelley Ltd. (Advertising), 150 Main St. E., Hamilton, Ont. (*H*) 25 Homewood Ave. (*S. 1914*) (*Jr. 1922*) (*A.M. 1926*)

♂GNAEDINGER, F. Theo., Lieut., M.M., B.Sc., (McGill '12), Str'l. Designer, T. Pringle & Son, Ltd., 420 Coristine Bldg., Montreal, Que. (*H*) Apt. 5, 222 Melville Ave., Westmount, Que. (*S. 1911*) (*Jr. 1916*) (*A.M. 1921*)

♂GOBY, Thomas, B.Sc., (Tri-State '25), Sales Engr. (Armco Culvert), W. Q. O'Neall Co., Crawfordsville, Ind. (*H*) 923 E. Hunter, Bloomington, Ind. (*S. 1921*) (*Jr. 1931*) (*A.M. 1934*)

GODDARD, Rolphe, Elgin, Albert Co., N.B. (*S. 1931*)

GODDEN, Chas. J., 55 Cochrane St., St. John's, Nfld. (*S. 1935*)

♂GODSON, Reginald Gilbert, Capt., Private Practice, 28 Summerhill Gardens, Toronto, Ont. (*A.M. 1935*)

GODWIN, Harold B., B.Sc., (McGill '28), Flt.-Lt., R.C.A.F., Camp Borden, Ont. (*S. 1925*)

GOEDIKE, Frederick B., B.Sc., (Queen's '10), 578-A Indian Rd., Toronto 9, Ont. (*S. 1910*) (*A.M. 1913*)

GOHIER, Jas. A. E., B.Sc., (McGill '13), D.L.S., Cons. Engr., 10 St. James St. E., Montreal, Que. (*H*) 821 Wilder Ave., Outremont, Que. (*M. 1934*)

GOLD, Wm. John, B.Sc., (Alta.'33), 11208-126th St., Edmonton, Alta. (*S. 1933*)

GOLDMAN, Hyman A., C.E., (Valparaiso '12), Apt. 2, 1125 Lajoie Ave., Outremont, Que. (*Jr. 1915*) (*A.M. 1918*)

GOODALL, E. Lorne, B.Sc., (McGill '24), Res Engr., Provincial Paper Ltd., Port Arthur, Ont. (*H*) 18 Winnipeg Ave. (*S. 1924*) (*Jr. 1929*) (*A.M. 1934*)

♂GOODCHILD, Ralph Henry, Lieut., Engr., Dom. Water Power Br., Calgary, Alta. (*H*) 3817-7A St. W. (*A.M. 1920*)

♂GOODMAN, H. Meyer, B.A.Sc., (Tor.), Imperial Bank Bldg., 171 Yonge St., Toronto, Ont. (*Jr. 1915*) (*A.M. 1917*)

GOODMAN, J.E., B.Sc., (Queen's '31), County Rd. Engr., County of Frontenac, Court House, Kingston, Ont. (*H*) 142 Albert St. (*Jr. 1931*) (*A.M. 1934*)

♂†GOODRICH, Chauncey M., Major, M.A., C.E., (Vermont), A.M., (Harvard), Chief Engr., Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 30 Moy Ave., Windsor, Ont. (*A.M. 1907*) (*M. 1916*)

GOODSPEED, Frederic G., M.A., B.Sc., (N.B. '04), Dist. Engr., D.P.W. Canada Customs Bldg., Winnipeg, Man. (*H*) 83 Canora St. (*A.M. 1909*) (*M. 1918*) (*Member of Council, E.I.C.*)

GOODSPEED, Herbert N., B.Sc., (N.B. '34), 745 George St., Fredericton, N.B. (*S 1934*)

♂GOODWIN, Edward Arthur, Major, Sales Engr., Griswold & Co. Ltd., 407 McGill St., Montreal, Que. (*H*) 3539 Lacombe Ave. (*A.M. 1934*)

♂GOODWIN, Leo Frank, Lt.-Col., Ph.D., (A.C.G.I.), Prof. Chem. Engrg., Queen's University, Kingston, Ont. (*H*) 311 King St. W. (*M. 1922*) (*Member of Council, E.I.C.*)

GORDON, Arthur I. E., B.A.Sc.Ci., (B.C. '27), B.A.Sc., Geol. '35, Premier Gold Mining Co., Premier, B.C. (*H*) 531-10th Ave. W., Vancouver, B.C. (*S. 1927*) (*Jr. 1932*)

GORDON, Chas. Howard, B.Sc., (McGill '24), (R.M.C. Kingston '22), Vice-Pres., The Atlas Construction Co., 679 Belmont St., Montreal, Que. (*H*) Cartierville, Que. (*Jr. 1925*) (*A.M. 1931*)

GORDON, H. C. M., B.Sc., (McGill '23), Asst. Mining Engr., Acadia Coal Co. Ltd., Stellarton, N.S. (*Jr. 1924*)

GORDON, Hugh John, B.Eng., (McGill '33), Dftsman, C.P.R., Montreal, Que. (*S 1933*)

♂GORDON, Jas. Lindsay, Brigadier, D.F.C., D.O.C., M.D. No. 10, Fort Osborne Barracks, Winnipeg, Man. (*H*) 241 Oxford St. (*A.M. 1924*)

GORDON, James MacKendrick, Sales Mgr., The Warren Bituminous Paving Co., 388 University Ave., Toronto, Ont. (*H*) 29 Woodlawn Ave. W. (*Jr. 1918*) (*A.M. 1919*)

GORDON, James P., (Tor. '04), Sidewalk Engr., City of Hamilton. (*H*) 133 Hyde Park Ave., Hamilton, Ont. (*S. 1907*) (*A.M. 1913*)

GORDON, John, Elect. Engr., C.N.R., Union Sta., Winnipeg, Man. (*H*) 252 Niagara St. (*A.M. 1920*)

GORDON, John Edward, 113 King St. W., Dundas, Ont. (*S. 1935*)

GORMAN, David Donald, B.Sc., (N.B. '34), 188 O'Dell Ave., Fredericton, N.B. (*S. 1934*)

GOUGH, R. W., B. Sc., (N.B., '26 and '32), 63 Shore St., Fredericton, N.B. (*S.1926*)

GRAHAM, Albert Lloyd, B.A.Sc., (Tor. '31), Eastern Power Devices, Ltd., 1244 Dufferin St., Toronto, Ont. (*H*) 1578 King St. W. (*S. 1932*)

♂GRAHAM, Andrew Geo., (R.T.C., Glasgow), City Engr., City Hall, Nanaimo, B.C. (*H*) 315 Kennedy St. (*A.M. 1919*)

GRAHAM, Chas. Allison, B.Eng., (McGill '34), Chesterville, Ont. (*S. 1934*)

GRAHAM, Frank Charles, Asst. City Engr., Port Arthur, Ont. (*H*) 157 College St. (*A.M. 1921*)

GRAHAM, Walter White, B.Sc., (McGill '25), Elec. Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 5746 Charlemagne Ave. (*S. 1923*) (*Jr. 1928*) (*A.M. 1935*)

GRAHAME, Dallas F., B.Sc., (McGill '10), Chief Engr., Atwood Ltd., 660 St. Catherine St. W., Montreal, Que. (*H*) 532 Grosvenor Ave., Westmount, Que. (*A.M. 1925*)

GRANDMONT, Bruno, B.A.Sc., C.E., Dist. Engr., Dept. P.W., Canada, Box 160, P.O. Bldg., Three Rivers, P.Q. (*S. 1913*) (*A.M. 1917*) (*Member of Council, E.I.C.*)

♂GRANGE, Edward Rochfort, Flt.-Cmdr., D.S.C., C. de G., B.A.Sc., (Tor. '15), Vice-Pres., Delamere & Williams, Ltd.; Pres., Delamere, Williams, Grange, Ltd.; Sec.-Treas., Vacu-Draft, Ltd., 18–32 Hook Ave., Toronto 2, Ont. (*H*) 34 Chicora Ave. (*S. 1914*) (*A.M. 1922*)

GRANSAULL, L. R., Land Surveyor, St. Joseph, Trinidad, B.W.I. (*S. 1905*) (*A.M. 1911*)

GRANSAULL, Paul R., Rd. Officer, Tacariqua Local Rd. Bd., Tunapuna, Trinidad, B.W.I. (*H*) St. Joseph. (*S.1905*) (*A.M. 1911*)

GRANT, Alex. Geo., B.A.Sc., (Tor. '27), 54 Golfdale Rd., Toronto 12, Ont. (*S 1927*) (*Jr. 1930*)

¥. GRANT, A. J., 16 Hillcrest Ave., St. Catharines, Ont. (*A.M. 1891*) (*M. 1901*) (*Past President*)

GRANT, Alex. J., Jr., B.Sc., (McGill '29), 2243 Grand Blvd., Montreal, Que. (*S. 1925*) (*Jr. 1931*)

GRANT, Clifford Gordon, N.B.L.S., Res Engr., Dept. of Highways, Fredericton, N.B. (*A.M. 1920*)

GRANT, Donald Seafield, Supt., Eugene F. Phillips Electrical Works Ltd., P.O. Box 729, 5795 de Gaspe Ave., Montreal, Que. (*H*) Apt. 4, 1120 Bernard Ave. W. (*S. 1930*)

GRANT, Eric, 3645 Jeanne Mance St., Montreal, Que. (*Jr. 1935*)

GRANT, Gordon, 334 Russell Hill Rd., Toronto 5, Ont. (*A.M. 1898*) (*M. 1906*) (*Life Member*)

♂GRANT, John R., Major, M.C., B.Sc., (Queen's '04), Cons. Engr., 1202 Bekins Bldg., Vancouver, B.C. (*H*) 2960 W. 44th Ave. (*S. 1903*) (*A.M. 1911*) (*M. 1914*)

GRANT, Joseph A., 475 Argyle Ave., Westmount, Que. (*A.M. 1907*)

GRANT, Lawford Stanley Foster, Pres. and Man. Dir., Eugene F. Phillips Electrical Works, Ltd., Montreal, Que. (*H*) 593 St. Joseph St., Lachine, Que. (*A.M. 1912*)

♂GRANT, LeRoy Fraser, Major, (R.M.C. Kingston '05), B.Sc., (Queen's '25), B.C.L.S., Assoc. Prof. of Engrg., Royal Military College, Kingston, Ont. (*H*) 83 Gore St. (*S. 1908*) (*A.M. 1913*) (*M. 1927*) (*Sec.-Treas., Kingston Br., E.I.C.*)

GRANT, Wilfrid J., B.A.Sc., (Tor. '22), Hamilton Trust Bldg., 57 Queen St. W., Toronto, Ont. (*H*) 102 Pemberton Ave., Willowdale, Ont. (*S. 1921*) (*Jr. 1931*)

GRANVILLE, Francis X., B.Sc., (N.S.T.C. '34), 111 South Park St., Halifax, N.S. (*S. 1930*)

GRATTON, Alphonse, B.A.Sc., (Ecole Polytech. Montreal '12), Q.L.S., Dist. Engr., Quebec Roads Dept., Parliament Bldgs., Quebec, Que.; Prof of Highway Engrg., University of Montreal. (*H*) Apt. 6, 84 St. Louis Rd., Quebec, Que. (*M. 1935*)

GRAV, Bjarne, M.E., (Oslo. '13), Mill Engr., Can. International Paper Co., P.O. Box 32, Temiskaming, Que. (*A.M. 1927*)

GRAVEL, Arthur L., B.Sc., (McGill '24), Bell Telephone Co. of Canada, Montreal, Que. (*H*) 3491 Atwater Ave. (*Jr. 1929*)

GRAVEL, L. P., B.Sc., (Ecole Polytech. Montreal '27), Dept. P.W., Parliament Bldgs., Quebec, Que. (*H*) 498 Royale Ave., Beauport, Que. (*S. 1923*) (*Jr. 1932*)

GRAY, Alexander, Chief Engr. and Gen. Mgr., Saint John Harbour Commrs., P.O. Box 1393, Saint John, N.B. (*H*) 28 Garden St. (*A.M. 1907*) (*M. 1916*) (*Vice-President, E.I.C.*)

♂GRAY, Andrew Jack, Lieut., B.A.Sc., (Tor. '13), Mech. Engr., Marine Iron Wks., 515 Pembroke St., Victoria, B.C. (*H*) 1066 St. Patrick St. (*A.M. 1919*)

GRAY, Donald A., B.Sc., (McGill '25), Sales Engr., English Electric Co. of Canada Ltd., Montreal, Que. (*H*) 4862 Melrose Ave., N.D.G. (*S. 1924*)

♂GRAY-DONALD, E. D., B.Sc., (McGill '26), M.Sc., (Laval '34), Supt., Power Divn., Quebec Power Co., Quebec, Que. (*H*) 12 St. Denis Ave. (*S. 1922*) (*Jr. 1926*) (*A.M. 1934*)

GRAY, Francis Wm., Asst. Gen. Mgr., Dom. Steel and Coal Corp., Sydney, N.S. (*A.M. 1921*) (*M. 1924*)

GRAY, John Hamilton, R.M.D.I., Albert Head, V.I., B.C. (*M. 1906*)

GRAY, Reg. Arthur Geo., Asst. Engr., Chief Elec. Engr.'s Office, C.N.R., Rm. 905, 355 McGill St., Montreal, Que. (*H*) 55-56th Ave., Lachine, Que. (*Jr. 1930*)

♂GRAY, Samuel Wilson, B.Sc., (N.S.T.C. '14), Asst. Hydr. Engr., N.S. Power Comm., Bank of N.S. Bldg., Halifax, N.S. (*H*) 4 Waterloo St. (*A.M. 1920*)

GREEN, F. C., B.A., (N.B.), D.L.S., B.C.L.S., Surveyor General of Prov. of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 347 Foul Bay.Rd. (*M. 1914*)

♂GREEN, F. Gordon, B.Sc., (McGill '21), M.Sc., Assoc. Research Chem., National Research Council, Ottawa, Ont. (*H*) Apt. 502, 404 Laurier Ave. E. (*S. 1920*) (*Jr. 1924*) (*A.M. 1929*)

GREEN, John S., B.A.Sc., (Tor. '34), Box 96, Hagersville, Ont. (*S. 1931*)

GREEN, Leonard, Sales Engr., Calgary Br., Crane Ltd., Calgary, Alta. (*H*) 535-12th Ave. N.E. (*A.M. 1923*)

GREENBERG, Louis, B.Sc., (McGill '93), Engr. and Contractor, 7 E. 42nd St., New York, N.Y. (*H*) 123 W. 47th St. (*S. 1892*) (*A.M. 1899*)

GREENE, Godfrey Benning, R.C M.P., Regina, Sask. (*H*) 26 Russell Ave., Ottawa, Ont. (*S. 1933*)

GREENE, John F., B.A., (M.I.T.), Ford, Bacon & Davis, Inc., 39 Broadway, New York, N.Y. (*H*) 63 Watchung Ave., Montclair, N.J. (*A.M. 1918*) (*M. 1919*)

♂†GREENE, Philip Weston, Capt., B.A.Sc., (Tor. '09), D.L.S., Sales Engr., United States Steel Products Co., 30 Church St., New York, N.Y. (*H*) 317 Lenox Ave., South Orange, N.J. (*S. 1908*) (*A.M. 1912*)

GREENWOOD, F. D., B.Sc., (Queen's '31), Mech. Dept., Hollinger Cons. Gold Mines Ltd., Box 2400, Timmins, Ont. (*H*) New Liskeard, Ont. (*S. 1928*) (*Jr. 1935*)

GREGOIRE, Armand E., B.A.Sc., (Ecole Polytech. Montreal '35), 6349 St. Denis St., Montreal, Que. (*S. 1935*)

♂GREGORY, Alex. Watson, Capt., M.C., Asst. Engr., Dept. P.W., N.S., Cunard Bldg., Halifax, N.S. (*Jr. 1912*) (*A.M. 1919*)

GREGORY, J. H., B.Eng., (McGill '34), Engr., Can. Blower and Forge Co. Ltd., Kitchener, Ont. (*H*) Y.M.C.A., Kitchener, Ont. (*S. 1933*)

GREGORY, H. A. F., B.A., (Bishop's '23), B.Sc., (McGill '27), Wayagamack Divn., Cons. Paper Corp., Three Rivers, Que. (*S. 1926*) (*Jr. 1931*)

GREGORY, P. S., B.A., B.A.Sc., (McGill '11), Asst. Gen. Mgr., The Shawinigan Water & Power Co., Montreal, Que. (*H*) 4081 Highland Ave. (*A.M. 1920*) (*M. 1925*)

GREIG, Alex. R., B.Sc., (McGill '95), Prof., Mech. Engrg., University of Saskatchewan, Saskatoon, Sask. (*S. 1895*) (*A.M. 1909*) (*M. 1919*)

GREIG, J. M. M., (R.T.C. Glasgow), Designer, Sanborn & Bogert, 30 Church St., New York, N.Y. (*H*) 101 Fairview Ave., Port Washington, L.I., N.Y. (*A.M. 1913*)

GREIG, Wm. B., Asst. Engr., City of Vancouver, City Hall, Vancouver, B.C. (*H*) 5874 Larch St. (*A.M. 1911*)

GRENON, John F., B.A., (Laval), Cons. Engr.; Chief Engr., Quebec & Chibougamau Rly. Co., Rue Racine, Chicoutimi, Que. (*H*) Blvd. Rivière du Moulin. (*S. 1907*) (*A.M. 1909*)

♂GRENZEBACH, Sylvester Leslie, B.A.Sc., (Tor. '24), Design. Engr., Toronto Hydro-Electric System, Toronto, Ont. (*H*) 604 Spadina Ave. (*S. 1920*) (*A.M. 1927*)

GRIESBACH, Robt. Jas., B.A.Sc., (Tor. '24), Engr., The Foundation Co. of Canada Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*H*) 478 Victoria Ave., Westmount, Que. (*S. 1923*) (*A.M. 1927*)

GRIESBACH, Walter, B.Sc., (Queen's '12), Chief Engr., The Foundation Co. of Canada, Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*H*) 478 Victoria Ave., Westmount, Que. (*S. 1912*) (*Jr. 1916*) (*A.M. 1922*)

GRIEVE, John, Sales Promotion Mgr., Imperial Varnish & Color Co., Ltd., Toronto, Ont. (*H*) 159 Forest Hill Rd. (*S. 1909*) (*A.M. 1915*) (*M. 1923*)

GRIFFIN, Augustus, B.Sc., (Calif. '06), Chief Engr., D.N.R., C.P.R., Calgary, Alta. (*H*) Strathmore, Alta. (*M. 1925*)

♂GRIFFIN, Frank F., Superv. Engr., Northwestern Power Co., Winnipeg Electric Rly. Chambers, Winnipeg, Man. (*H*) 23 Brussels Apts. (*S. 1907*) (*A.M. 1913*)

GRIFFITH, John, Bron Seiont, Segontium Terrace, Caernarvon, N. Wales. (*A.M. 1919*)

GRIFFITH, John Edgar, 1229 Oliver St., Oak Bay, Victoria, B.C. (*M. 1912*)

♂GRIFFITHS, Geo. Ewart, B.A.Sc., (Tor. '15), Meter Engr., H.E.P.C. of Ont., Box 385, Thorold, Ont. (*A.M. 1933*)

GRIFFITHS, Geo. H. R., B.Sc., (Man. '35), 212 Forest Ave., W. Kildonan, Man. (*S. 1935*)

GRIFFITHS, W. E., B.Sc., (McGill '31), 116 Indian Rd., Toronto, Ont. (*Jr. 1930*)

GRIME, Leonard, B.A.Sc., (Tor. '26), Engr., National Silicates Ltd., New Toronto, Ont. (*H*) 26 Leopold St. (*Jr. 1928*)

GRIMMER, Allan K., B.A.I., M.Sc., (N.B. '07), Engr., Town Dept., Can. International Paper Co., Temiskaming, Que. (*H*) 293 Kipawa Rd. (*A.M. 1910*) (*M. 1920*)

GRINDLEY, Frank L., B.Sc., (Alta. '26), Jr. Engr., Water Development Committee, Swift Current, Sask. (*H*) 10942–80th Ave., Edmonton, Alta. (*S. 1925*) (*Jr. 1928*)

GROLEAU, A. J., B.Sc., (McGill '28), Asst. Dist. Traffic Supt., Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 4396 Coolbrook Ave. (*S. 1928*)

GROSS, Philip Norcross, B.Sc., (McGill '26), Vice-Pres. and Mgr., Anglin-Norcross Ontario Ltd., 57 Bloor St. W., Toronto, Ont. (*H*) 16 Hawthorn Ave. (*A.M. 1932*)

GROVE, Humphrey S., B.Sc., (McGill '09), Designing Engr., Power Corpn. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 135 Brock Ave. S. (*Jr. 1913*) (*A.M. 1918*)

GROVES, F. W., B.C.L.S., Cons. Engr., Box 136, Kelowna, B.C. (*M. 1913*)

GRUENIG, Ernest, Designing Engr., The Montreal Water Bd., 3161 Joseph St., Montreal, Que. (*H*) 5456 Western Ave. (*A.M. 1929*)

♂GRUMMITT, Edmund, Asst. to City Engr., Municipality of St. Catharines, Ont. (*H*) 14 Elm St. (*A.M. 1917*)

GRUNSTEN, A. W., B.A.Sc., (Tor. '28), Can. Industries, Ltd., P.O. Box 1260, Montreal, Que. (*H*) 4452 Beaconsfield Ave. (*Jr. 1928*)

GUAY, Jean F., Dept. P.W. and L., Registrar of Bridges, Parliament Bldgs., Quebec, Que. (*A.M. 1887*) (*M. 1907*) (*Life Member*)

GUIMONT, Michael L., B.Sc., Deputy-Director, Unemployment Relief, D.P.W. & L., Parliament Bldgs., Quebec, Que. (*H*) 192 Maisonneuve Ave. (*S. 1906*) (*A.M. 1912*)

GUMLEY, F. Stewart, Designing Engr., Martin & Co., Calcutta, India. (*H*) Columbarian Cottage, Selkirk, Scotland. (*A.M. 1931*)

♂GUNN, Angus Stirling, Lieut., M.C., Right of Way Engr., C.N.R., Moncton, N.B. (*H*) 76 John St. (*A.M. 1921*)

♂GUNN, Cecil Herbert, Schultz & Sutherland, 508 Avenue Blk., Winnipeg, Man. (*H*) 52 Roslyn Rd. (*Jr. 1920*) (*A.M. 1921*)

GUNN, William W., B.A.Sc., (Tor. '10), Engr., Dom. Bridge Co., Ltd., Reford Bldg., Toronto, Ont. (*H*) 251 Lytton Blvd., Toronto 12, Ont. (*A.M. 1917*)

GUNNING, M. P., B.Eng., (McGill '35), 591 Notre Dame Ave., St. Lambert, Que. (*S. 1935*)

GURNHAM, Robt. Allan, Works Mgr., Darling Bros., Ltd., 140 Prince St., Montreal, Que. (*H*) 5811 Notre Dame de Grace Ave. (*A.M. 1925*)

♂GUTHRIE, Kenneth MacGregor, Sqdn. Ldr., Dept. of National Defence, Woods Bldg., Ottawa, Ont. (*H*) 103 Acacia Ave., Rockcliffe Park. (*Jr. 1926*) (*Affil. 1934*)

♂GUY, Richard W., M.M., B.Sc., (McGill '15), Sr. Examiner, Dept. Trade and Commerce, Rm. 124 West Block, Ottawa, Ont. (*H*) 451 Echo Drive. (*S. 1914*) (*Jr. 1926*) (*A.M. 1930*)

GZOWSKI, Casimir Stanislaus, Chief Engr., Constrn. Dept., C.N.R., 360 McGill St., Montreal, Que. (*H*) 6 Belvedere Rd., Westmount, Que. (*S. 1897*) (*A.M. 1904*) (*M. 1909*)

♂GZOWSKI, Harold N., Major, Pres., Toronto Ignition Co. Ltd., 1366 Yonge St., Toronto, Ont. (*H*) 63 Wells Hill Ave. (*S. 1907*) (*A.M. 1911*)

G †HAANEL, Benj. F. C., B.Sc., (Syracuse '99), Chief of Divn., Divn. of Fuels and Fuel Testing, Mines Branch, Dept. of Mines, Ottawa, Ont. (*H*) 236 First Ave. (*M. 1918*)

HADDIN, John, Haddin & Miles, Ltd., Gen. Cons. Practice, 9 Argyle Court, Calgary, Alta. (*A.M. 1911*) (*M. 1913*)

HADDOW, A. W., B.Sc., (Queen's '09), City Engr., Edmonton, Alta. (*H*) 10635–125th St. (*A.M. 1916*)

♂HADLEY, Arthur, Designing Dftsman., H.E.P.C. of Ont., Toronto, Ont. (*H*) 25 Webb Ave. (*A.M. 1921*)

♂HADLEY, Henry, Lieut., B.Sc., (McGill '06), City Engr., Verdun, Que. (*H*) 261 Moffat St. (*S. 1904*) (*A.M. 1909*)

♂HADLEY, W. F., Lt.-Col., (R.M.C., Kingston '14), Mgr., Scott Estate, 17 Main Street, Hull, Que. (*H*) 28 Aylmer Rd. (*S. 1914*) (*Jr. 1919*) (*A.M. 1930*)

HAGERMAN, Bernard Harrison, B.Sc., (N.B. '23), Asst. Bridge Engr., D.P.W., N.B. (*H*) 74 Lansdowne St., Fredericton, N.B. (*Jr. 1923*)

♂HAGGAS, Ernest, Designing Dftsman., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) Rosseau Rd., Bartonville, Ont. (*A.M. 1931*)

HAGGERT, Gordon J., B.A.Sc., (Tor. '27), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 62 Hammersmith Ave. (*S. 1928*)

HAGUE, Edward Cousins, B.Sc., (McGill '23), Chief Engr., Erie Resistor Ltd., Carlisle Rd., The Hyde, Hendon, London, N.W.9, England. (*S. 1922*) (*A.M. 1930*)

HAIGHT, Harry Vercoe, B.A.Sc., (Tor. '97), Wks. Mgr., Ingersoll-Rand Co., Ltd., Lyons Rd., Trafford Park., Manchester, England. (*H*) Shandon, Harboro Rd., Ashton-on-Mersey, Cheshire, England. (*M. 1920*)

♂HAIMES, Jas., City Engr., City of Lethbridge, City Hall, Lethbridge, Alta. (*H*) 818 15th St. So. (*A.M. 1925*)

HAINES, Julius H., B.Sc., (McGill '30), Address unknown. (*S. 1929*)

HAIRSINE, Sydney, Asst. Elec. Engr., Welland Ship Canal, Dept. of Rlys. and Canals, St. Catharines, Ont. (*H*) 97 Highland Ave. (*A.M. 1932*)

HALE, Geo. Raymond, S.B., (Harvard '12), M.Sc., Elec. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 38 Lazard Ave., Town of Mt. Royal, Que. (*A.M. 1927*)

HALL, Donald D., B.Sc., (Queen's '30), Dom. Natural Gas Co. Ltd., St. Catharines, Ont. (*H*) 55 Marquis St. (*S. 1928*)

HALL, John G., B.Sc., (McGill '21), Gen. Mgr., Combustion Engineering Corp., Ltd., 540 Dominion Square Bldg., Montreal, Que. (*H*) 870 Hartland Ave. (*S. 1919*) (*A.M. 1924*) (*M. 1931*)

♂HALL, Norman MacL., Major, O.B.E., B.Sc., (McGill '07), Prof. Mech. Engrg., University of Manitoba, Winnipeg, Man., also Consulting Engr. (*H*) 22 Dundurn Place, Winnipeg, Man. (*S. 1907*) (*A.M. 1913*) (*M. 1923*)

HALL, Stewart Wm., B.A.Sc., (Tor. '28), Plan Examiner, Arch't.'s Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 393 Montrose Ave. (*Jr. 1929*) (*A.M. 1934*)

HALL, Thos. Leonard, B.Sc., (N.B. '28), Sales Engr., Can. Gen. Elec. Co. Ltd., Notre Dame Ave., Winnipeg, Man. (*H*) 152 Garfield St. (*S. 1928*)

HALL, Walter Elten Logan, Private Practice, P.O. Box 277, Windsor, N.S. (*A.M. 1921*)

HALLEY, W. C. H., Petty Harbour, St. John's West, Nfld. (*S. 1932*)

HALPENNY, M. B., BSc., (McGill '26), Estimator, Dominion Bridge Co. Ltd., Box 4016, Montreal, Que. (*H*) 4935 Connaught Ave., Montreal, Que. (*S. 1923*) (*A.M. 1931*)

HALTALIN, Clifford P., B.Sc., (Man. '29), Jr. Asst. Engr., Winnipeg Electric Co., Winnipeg, Man. (*H*) 636 Toronto St. (*S. 1927*) (*A.M. 1934*)

HAMEL, J. Albert, B.Sc., (McGill '27), Prof., Technical School, 642 Notre Dame St., Three Rivers, Que. (*S. 1920*) (*A.M. 1927*) (*Sec.-Treas., St. Maurice Valley, Br. E.I.C.*)

HAMILTON, Cecil R., B.Sc., (N.S.T.C. '34), Weymouth, N.S. (*S. 1930*)

HAMILTON, Chas. Thomas, B.A.Sc., (Tor. '09), D.L.S., B.C.L.S., Cons. Engr., 76-615 Hastings St. W., Vancouver, B.C. (*H*) 2044–44th Ave., W. (*A.M. 1917*)

HAMILTON, Chester B., Jr., B.A.Sc., (Tor. '07), Pres. and Mech. Engr., The Hamilton Gear and Machine Co., 76 Van Horne St., Toronto, Ont. (*H*) 6 Frank Crescent. (*M. 1918*)

HAMILTON, Parker C., B.Sc., (N.S.T.C. '33), 242 Oxford St., Halifax, N.S. (*S. 1932*)

HAMILTON, Robt. Wm., B.Sc., (McGill '29), Elec. Engr., Dom. Electric Protection Co., 2040 Clarke St., Montreal, Que. (*H*) 113 Brock Ave. S., Montreal West, Que. (*S. 1925*)

HAMILTON, Vesey Courthope, (R.M.C., Kingston '24), Supt., Canada Cement Co. Ltd., Exshaw, Alta. (*A.M. 1935*)

HAMILTON, W. Garrison, B.Sc., (N.S.T.C. '35), Engrg. Dept., Can. Johns-Manville Co., Asbestos, Que. (*S. 1930*)

♂HAMMERSLEY-HEENAN, John, Capt., Pan-Pacific Piling and Construction Co., Box 389, Wilmington, Calif. (*A.M. 1911*)

HAMMOND, R. E., B.A.Sc., (Tor. '33), M.A.Sc., '34, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1216 St. Matthew St. (*S. 1931*)

♂HANCOX, Frederick Jas., Chief Designer, Sewer Section, City of Toronto, Toronto, Ont. (*H*) 119 Neville Park Blvd. (*A.M. 1920*)

♂HANDLEY, John, Lt.-Col., M.E., Dip.A., (Cantab.), P.O. Box 54, Noranda, Que. (*S. 1904*) (*A.M. 1907*)

HANGO, J. R., B.Sc., (Alta.' 29), Asst. Elec. Engr., Duke-Price Power Co. Ltd., Arvida, Que. (*H*) 207 Radin Rd. (*S. 1928*) (*A.M. 1935*)

HANKIN, Edmund Alfred, B.Eng., (McGill '34), Engr., Francis Hankin & Co. Ltd., 165 Spadina Ave., Toronto, Ont. (*S. 1934*)

HANKIN, Francis, Pres., Francis Hankin & Co., 2028 Union Ave., Montreal, Que. (*H*) 648 Murray Hill (*Affil. 1920*)

HANLY, Arthur F., Rm. 901, Read Bldg., 420 Lagauchetiere St. W., Montreal, Que. (*A.M. 1920*)

HANLY, John Bruce, B.A.Sc., (Tor. '31), 78 Grosvenor St., Toronto, Ont. (*S. 1930*)

HANNA, Harold B., B.Sc., (Queen's '24), Can. Industries Ltd., Montreal, Que. (*H*) 4836 Westmore Ave. N.D.G. (*S. 1922*) (*Jr. 1926*) (*A.M. 1931*)

♂HANNA, John Jeffery, Capt., B.A.Sc., (Tor '14), Asst. Supt., Imperial Oil Ltd., Ogden Rd., Calgary, Alta. (*H*) 1122 Frontenac Ave. (*A.M. 1917*)

HANNAFORD, Arthur R., Office and Designing Engr., City Engr.'s Dept., Corp. of the City of Hamilton, Hamilton, Ont. (*H*) 354 Herkimer St. (*A.M. 1920*)

HANNING, George Foster, (Tor. '99), Grimsby, Ont. (*A.M. 1897*)

HANSEN, Darrel Adrian, B.Sc., (Alta. '28), Asst. Dist. Engr., Calgary Power Co., 107 Commercial Bldg., Edmonton, Alta. (*H*) 11023–64th A. St. (*A.M. 1934*)

HANSON, Myron W., C.E., (Ohio Nor. '10), Designing Engr., Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa. (*M. 1927*)

HANSON, Ralph Ellis, B.Sc., (N.S.T.C. '28), D.L.S., Hydrographic Service, Marine Dept., Hunter Bldg., Ottawa, Ont. (*H*) 341 MacLaren St. (*A.M. 1933*)

HARBERT, Edward Thomas, B.Sc., (McGill '23), Engr., Can. Ingersoll-Rand Co. Ltd., Box 728, Sherbrooke, Que. (*S. 1920*) (*Jr. 1928*)

HARDCASTLE Sydney, B.A.Sc., (Tor. '24), Asst. Str'l. Engr., D.P.W., Chief Arch't. Br., Rm. 922, Hunter Bldg., Ottawa, Ont. (*H*) 115 Sunnyside Ave. (*S. 1920*) (*A.M. 1931*)

HARDING, Sidney, S.L.S. Private Practice, Punnichy, Sask (*A.M. 1921*)

HARDING, Sidney H., B.Sc., (N.B. '34), Apohaqui, Kings Co., N.B. (*S. 1934*)

HARDY, George F., B.S., Hydr. Engr. and Mill Architect, 305 Broadway, New York, N.Y. (*H*) Crydero Court, White Stone, N.Y. (*M. 1902*)

HARDY, R. M., B.Sc., (Man. '29), M.Sc., (McGill '30), D.L.S., A.L.S., Lecturer in C.E. University of Alberta, 105 Science Bldg., Edmonton, Alta. (*S. 1928*) (*Jr. 1934*) (*Sec.-Treas., Edmonton Br., E.I.C.*)

♂HARDY, Wm. Gathorne, Capt., B.Sc., (N.S.T.C. '20), N.S.L.S., 4879 Patricia Ave., N.D.G., Montreal, Que. (*A.M. 1935*)

HARE, Chas. M., B.Sc., (McGill '29) Foundation Co. of Canada, W. Saint John, N.B. (*H*) 264 St. James St. (*S. 1928*)

†HARE, G. G., B.A.Sc., (McGill '96), City Engr., Saint John, N.B. (*H*) 264 St. James St. (*S. 1894*) (*A.M. 1908*) (*M. 1920*) (*Life Member*)

HARE, W. L., B.Sc., (Queen's '35), 673 Gilmour St., Ottawa, Ont. (*S. 1935*)

HARGROVE, Paul, B.Sc., (Alta. '28), Alcomdale, Alta. (*S. 1927*) (*Jr. 1931*)

HARKNESS, Aleck L., B.A.Sc., (Tor. '08), 232 Portland Ave., Mount Royal, Que. (*S. 1907*) (*A.M. 1911*)

HARKNESS, Andrew Harkness, B.A.Sc., (Tor. '08), Harkness & Hertzberg, Rms. 620–622 Bloor Bldg., 57 Bloor St. W., Toronto, Ont. (*H*) 185 Glencairn Ave. (*A.M. 1912*) (*M. 1917*)

HARKNESS, Harold W., B.Sc., (Queen's), M.Sc., Ph.D., (McGill), Assoc. Prof. of Physics, Acadia University, Box 434, Wolfville, N.S. (*A.M. 1920*) (*M. 1931*)

HARKNETT, Stewart Geo., Mgr., Elec. Dept., Mumford, Medland, Ltd., Wall St., Winnipeg, Man. (*H*) 222 Melbourne Ave., E. Kildonan. (*A.M. 1934*)

♂HARKOM, John Frederick, Capt., M.C., B.Sc., (McGill '14), Forest Products Laboratories of Canada, Dept. Interior, Ottawa, Ont. (*S. 1912*) (*Jr. 1918*) (*A.M. 1925*)

HARRIGAN, Mayo, B.Sc., (Dalhousie '30), B.Sc., (N.S.T.C. '33), 244½ Barrington St., Halifax, N.S. (*S. 1930*)

HARRINGTON, Arthur Russell, 82 Cambridge St., Halifax, N.S. (*S. 1932*)

†HARRINGTON, J. Lyle, B.A., M.Sc., (McGill), C.E., (Kansas), D.Eng., (Case), Harrington & Cortelyou, Cons. Engrs., 1004 Baltimore Ave., Kansas City, Mo. (*H*) 111 West Armour. (*M. 1905*)

HARRIS, Arthur Clifford, B.Sc., (N.S.T.C. '27), Asst. Engr., City of Halifax, City Hall, Halifax, N.S. (*H*) 256 Almon St. (*S. 1927*) (*Jr. 1928*)

HARRIS, Richard Crosby, Div. Engr., C.P.R., Calgary, Alta. (*H*) 1016-15th Ave. W. (*A.M. 1919*) (*M. 1926*)

HARRIS, Wallace R., Project Engr., Works Progress Administration, Milwaukee, Wis. (*H*) 2611 W. Juneau Ave., Milwaukee, Wis. (*M. 1916*)

HARRISON, Albert Dex, 4693 Cote St. Catherine Rd., Montreal, Que. (*M. 1931*)

♂HARRISON, Edward Harrison, Capt., M.C., Private Practice, 121 Sloane St., London, S.W.1, England. (*A.M. 1906*) (*M. 1920*)

HARRISON, Noel F., Civil and Elec. Engr., Private Pactice, Bray Head, County Wicklow, Ireland. (*H*) "Sliab Fana," Bri Cualann. (*A.M. 1922*)

♂HARRISON, Ronald, Lieut., B.A.Sc., (Tor. '20), Mgr. and Sec.-Treas., Hydro and Water Depts., Scarboro Utilities Comm., 1666 Kingston Rd., Toronto, Ont. (*H*) 1859 Kingston Rd., Birchcliff, Ont. (*S 1919*) (*Jr. 1921*) (*A.M. 1925*)

HARRISON, Ronald Dex, B.Eng., (McGill '34), 4693 Cote St. Catherine Rd., Montreal, Que. (*S. 1934*)

♂HARRY, Wilmot Earl, Capt., M.C., Dept. National Defence, Nakina, Ont. (*A.M. 1920*)

HART, Henry Utler, Vice-Pres. and Chief Engr., Can. Westinghouse Co., Hamilton, Ont. (*H*) 3 Ravenscliffe Ave. (*M. 1907*)

HART, Herbert Trench, B.Eng., (McGill '32), c/o The Jamaica Theatres, Ltd., Box 211, Kingston, Jamaica, B.W.I. (*S. 1930*)

HART, W. O., B.Sc., (Queen's '29), Sales and Adv. Mgr., Oshawa Dairy Ltd., Oshawa, Ont. (*H*) 431 Simcoe St. S. (*S. 1928*)

HARTLEY, Eric L., B.Sc., (Queen's '33), Jas. Richardson & Sons Ltd., 1032 Grain Exchange, Winnipeg, Man. (*H*) Ste. 4, "Lee Court," Donald St. (*S. 1933*)

HARTNEY, Jas. R., B Sc., (McGill '30), Inspr., Can. Fire Underwriters' Assoc., Sprinkler Risk Dept., 628 Coristine Bldg., Montreal, Que. (*H*) 244 Merceille Ave., St Lambert, Que. (*S. 1930*)

♂HARVEY, Chas., B.A.Sc., (Tor. '01), D.L.S., Engr., Dept. of Highways, Ont. (*H*) 356 McLaren St., Ottawa, Ont. (*A.M. 1921*)

HARVEY, D. W., B.A.Sc., (Tor. '10), Gen. Mgr., Toronto Transportation Comm., Toronto, Ont. (*H*) 10 Shorncliffe Ave. (*S. 1909*) (*A.M. 1914*) (*M. 1932*)

HARVEY, St. George, Sec.-Treas., The Kennedy Construction Co. Ltd., 407 McGill St., Montreal, Que. (*H*) 722 Roslyn Ave., Westmount, Que. (*A.M. 1905*)

HARVEY, W. M., B.Sc., (Queen's '24), P.O. Box 724, New Liskeard, Ont. (*S. 1922*)

HARVIE, A. C., B.Sc., (Queen's '23), Box 602, Port Colborne, Ont. (*S. 1922*) (*Jr. 1927*)

HARVIE, Ralph Andrew, Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. W. (*S. 1927*)

HARVIE, Thomas White, 633 Cote St. Antoine Rd., Westmount, Que. (*A.M. 1911*) (*M. 1923*)

HARZA, LeRoy Francis, B.S., (S. Dakota State '01), B.S., (Wis. '08), Cons. Engr., Pres., Harza Engineering Co., 205 W. Wacker Drive, Chicago, Ill. (*H*) 2299 Pierce Rd., Highland Park, Ill. (*M. 1928*)

HASTINGS, Mereoith H., B.Sc., (Queen's '31), 57 Church St., Weston, Ont. (*S. 1928*)

HASTINGS, Walter Hindson, B.Sc., (McGill '22), Dept. of Natural Resources, Sask., Parliament Bldgs., Regina, Sask. (*H*) 152 Connaught Cres. (*A.M. 1927*)

HATFIELD, Geo. N., Road Engr., Corpn. of the City of Saint John, N.B. (*H*) 122 Broad St. (*S. 1909*) (*A.M. 1915*)

HATFIELD, Goroon Wallace, B.Sc., (McGill '31), Chief Chem., B. D. Beamish Sugar Refinery, Fleet and Bathurst Sts., Toronto, Ont. (*H*) 11 Walmer Rd. (*Jr. 1933*)

HATHAWAY, Jos. Dean, Vice-Pres., Northern Electric Co. Ltd., Montreal, Que. (*H*) 700 Aberdeen Ave., Westmount, Que. (*M. 1920*)

HAULT, G. C., B.Sc., (N.S.T.C. '31), Asst. Engr., Dept. of Highways, N.S. (*H*) 31 Woodill St., Sydney, N.S. (*S. 1929*)

HAULTAIN, H. E. T., C.E., (Tor.), Prof. of Mining Engrg., University of Toronto, Toronto, Ont. (*M. 1901*)

HAVENS, Verne Leroy, Engr. Examiner, U.S. Govt., P.W. Administration, P.O. Box 1065, San Francisco, Calif. (*H*) 47 Vallejo St., Berkeley, Calif. (*M. 1922*)

HAVILAND, Frank Leslie, (Tor. '08), Vice-Pres. and Ch. Engr., Standard Steel Construction Co., Welland, Ont. (*H*) 153 Aqueduct St. (*M. 1928*)

HAWKE, Chas. Eoison, B.A.Sc., Asst. Engr., P.W.D., Canada, 24 Adelaide St. E., Toronto, Ont. (*H*) 91 St. George St. (*S. 1930*)

HAWKER, Frank Edward, Can. Johns-Manville Co. Ltd., Halifax, N.S. (*H*) 55½ Le Marchant St. (*S. 1920*)

HAWKES, Horace H., Str'l. Designer, Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 75 Percival Ave., Montreal West, Que. (*A.M. 1921*)

HAWKINS, Jas. E., B.Sc., (Alta. '32), Lethbridge Junior Technical School, 636-11th St. So., Lethbridge, Alta. (*S. 1932*)

HAWLEY, Geo. P., Res. Engr., Montreal Island Power Co., P.O. Box 1710, Montreal, Que. (*H*) 10844 St. Hubert St. (*M. 1920*)

HAWTHORNE, Donald J., Wks. Mgr., Western Clock Co., La Salle, Ill. (*A.M. 1930*)

♂HAWTHORNE, George, Asst. Engr., Turbine Erection, H.E.P.C. of Ont., Fraserdale, Ont. (*H*) Box 328, Campbellford, Ont. (*A.M. 1926*)

HAY, Adam, Chief Dftsman., Dept. Public Highways, Ont., Parliament Bldgs., Toronto, Ont. (*H*) 479 Dovercourt Rd. (*A.M. 1921*)

♂HAY, Alan K., Lieut., B.Sc., (McGill '14), Ottawa Suburban Roads Comm., 279 Carling St., Ottawa ,Ont. (*H*) 20 Lakeview Terrace. (*S. 1914*) (*A.M. 1919*)

HAY, Alexander Loudon, Asst. Mining Engr., Dom. Coal Co., Box 643, Glace Bay, N.S. (*H*) 702 Official Row. (*A.M. 1921*) (*M. 1925*)

HAY, Edward Campbell, B.A.Sc., (B.C. '30), Sales Correspondent, Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. W. (*S. 1928*)

♂HAY, Marshall Neil, B.Sc., (Queen's '23), Supt., Aluminum Co. of Canada, Ltd., 158 Sterling Rd, Toronto 3, Ont. (*H*) 22 Austin Cres. (*Jr. 1924*) (*A.M. 1927*)

♂HAY, Wm. Wren, B.Sc., C.E., (Vermont '10), H. Cassel & Co., 61 Broadway, New York, N.Y. (*H*) 511 West 112th St. (*S. 1910*) (*Jr. 1914*) (*A.M. 1919*)

HAYCOCK, Richard LaF., B.Sc., (McGill), Mech. Engr., J. R. Booth, Ltd., Ottawa, Ont. (*H*) 345 Stewart St. (*M. 1919*)

HAYES, Elbert Harvey, B.Sc., (N.B. '28), Northern Electric Co. Ltd., Montreal, Que. (*H*) 4906 Queen Mary Rd. (*S. 1927*)

HAYES, Gerald Jos., B.Sc., (N.S.T.C. '33), Chatham, N.B. (*S. 1933*)

HAYES, Herman R., B.Sc., (Alta. '34), 19 Diana Court, Medicine Hat, Alta. (*H*) Gleichen, Alta. (*S. 1933*)

♂HAYES, Jas. Bertram, B.Sc., (Dalhousie '13), S.B., (C.E.), (N.S.T.C. '16), Mgr., N.S. Light & Power Co. Ltd., Capitol Bldg., Halifax, N.S. (*H*) "Kelavi," Armdale P.O., N.S. (*A.M. 1920*)

HAYES, Roland Earle, B.Sc., (McGill '24), Engrg. Dept., General Supply Co. of Canada, Ltd., 360 Sparks St., Ottawa, Ont. (*H*) 267 Powell Ave. (*Jr. 1928*)

HAYES, Ronald A. H., B.Sc., (McGill '28), Bloomfield Sta., N.B. (*S. 1922*)

HAYES, St. Clair J., B.S., (N.S.T.C. '23), Lecturer in Engrg., Memorial University College, St. John's, Nfld. (*S. 1923*) (*Jr. 1926*)

HAYMAN, Howaro L., B.A.Sc., (Tor. '23), Supt., John Hayman & Sons Co. Ltd., 432 Wellington St., London, Ont. (*H*) 114 Base Line Rd. (*A.M. 1933*)

♂HAYNE, Harry Louis, Capt., M.C., Dist. Engr., D.P.W., Pouce Coupe, B.C. (*A.M. 1920*)

HAYS, David Walker, B.Sc., (Nevada), Gen. Mgr., Canada Land and Irrigation Co. Ltd., Box 677, Medicine Hat, Alta. (*M. 1918*)

♂HAZEL, Frederick Brackenridge, B.Sc., (St. Andrews '11), Bldg Inspr., Man., Rm. 29, Parliament Bldg., Winnipeg, Man. (*H*) 152 Genthon St., Norwood, Man. (*A.M. 1920*)

HAZELTON, W. B., B.Sc., (N.B. '34), Beebe, Que. (*S. 1934*)

HAZEN, Hugh T., Chief Engr., Atlantic Region, C.N.R., Moncton, N.B. (*H*) 178 Church St. (*A.M. 1896*) (*M. 1906*)

†HEAMAN, John Anorew, B.Sc., (McGill '02), Office Engr., C.N.R., 360 McGill St., Montreal, Que. (*S. 1901*) (*A.M. 1909*) (*M. 1916*)

HEARN, Richaro L., B.A.Sc., (Tor. '13), Chief Engr., H. G. Acres & Co. Ltd., Niagara Falls, Ont. (*H*) 875 Roberts St. (*A.M. 1920*) (*M. 1925*)

♂HEARTZ, Richaro Eogar, Lieut., B.Sc., (McGill' 17), Asst. Chief Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 208 Portland Ave., Town of Mount Royal, Que. (*S. 1917*) (*A.M. 1926*) (*M. 1933*)

♂HEATLEY, Albert Harolo, B.A.Sc., M.A., (Tor. '23). Dept. of Electrochemistry, University of Toronto, Toronto, Ont. (*H*) 274 Winona Drive. (*S. 1921*) (*Jr. 1926*) (*A.M. 1931*)

HEAVYSEGE, Bruce Reio, B.Eng., (McGill '33), Hollinger Cons. Gold Mines, Ltd., P.O. Box 310, Timmins, Ont. (*S. 1933*)

HEBERT, Camille Raymond, 4079 St. Hubert St., Montreal, Que. (*S. 1935*)

HECKLE, George R., Cons. Engr., 50 Church St., New York, N.Y. (*H*) 96 Highland Ave., Yonkers, N.Y. (*M. 1914*)

HECKMAN, Jos. Wm., B.E., (King's '76), Apt. 3, 2290 Girouard Ave., Montreal, Que. (*A.M. 1887*) (*Life Member*)

HEDLEY, C. E., 40 Springwell Ave., Harlesden, London, N.W.10, England. (*S. 1929*)

HEENEY, Caroen Thos., B.Sc., (McGill '26), Asst. Engr. and Transitman, Gatineau Power Co., Jackson Bldg., Ottawa, Ont. (*H*) 250 Frank St (*S. 1927*)

HEIMBURGER, Boris, B.A.Sc., (Tor. '32), Bulevarden 15, Helsingfors, Finland (*S. 1931*)

HEMMERICK, George, B.Sc., (Queen's '16), Can. Sales Engr., Dow Chemical Co., 157 Bay St., Toronto, Ont. (*H*) 157 Colin Ave. (*S. 1916*) (*A.M. 1918*)

HENDERSON, Balfour, Instr'man, C.N.R., Winnipeg, Man. (*H*) Ste. 6, Dorchester Apts. (*A.M 1920*)

HENDERSON, Henry Banks, B.S., M.E., M.M.E., (Cornell '95), Mgr., Cowin & Co., Ltd., Pacific and Yeoman Sts., Winnipeg, Man. (*H*) 125 Hargrave St. (*M. 1921*)

HENDERSON, Ian Goroon, B.Sc., (McGill '26), Williamstown, Ont. (*S. 1925*) (*Jr. 1928*)

♂HENDERSON, John Alexander, Major, B.A., B.A.I., (T.C.D.), Address unknown. (*A.M. 1924*)

♂HENDERSON, John Archibalo Hamilton, B.Sc., (Queen's '22), Can. International Paper Co., 1155 Beaver Hall Sq., Montreal, Que. (*H*) 469 Lansdowne Ave., Westmount, Que. (*Jr. 1921*) (*A.M. 1923*)

HENDERSON, Juoson Pulforo, M.A., (Tor. '15), Astronomer, Dominion Observatory, Ottawa, Ont. (*H*) Box 204, Westboro, Ont. (*A.M. 1923*)

HENDERSON, Robert P., B.Sc., (Man. '30), Dist. Engr.'s Office, D.P.W., 3rd Floor, Customs Bldg., Winnipeg, Man. (*H*) 264 Wellington Cres. (*S. 1929*)

HENDERSON, Roy Manwaring, B.S. in E.E., (Armour '07), (E.E., '06), Pres., United Engineers and Constructors Inc., 111 W. Washington St., Chicago, Ill. (*H*) 1501 Hinman Ave., Evanston, Ill. (*M. 1929*)

HENDERSON, Samuel E. M., (Tor. '00), Mgr., Switchboard Dept., Can. Gen. Elec. Co., 212 King St. W., Toronto, Ont. (*H*) 38 Jameson Ave. (*M. 1929*)

HENDERSON, Thos. Robert, 25 Alva St., Edinburgh, Scotland. (*A.M. 1892*) (*M. 1905*) (*Life Member*)

HENDRICK, M. M., B.A.Sc., (Tor. '32), F/O, R.C.A.F., Camp Borden, Ont. (*S. 1932*)

HENDRY, Murray Calder, B.A.Sc., (Tor. '09), H.E.P.C. of Ontario, 620 University Ave., Toronto, Ont. (*A.M. 1908*) (*M. 1920*)

HENEY, F. G. G., Westboro, Ont. (*S. 1927*)

†HENRY, R. A. C., B.A., B.Sc., (McGill '12), Vice-Pres. and Gen. Mgr., Beauharnois Power Corp., Ltd., 405 Power Bldg., Montreal, Que. (*S. 1910*) (*A.M. 1913*) (*M. 1920*)

HENRY, Thomas, B.A.Sc., (Tor. '31), Elec. Engr., Square D Co. of Canada, Ltd., 672 Dupont St., Toronto, Ont. (*H*) 35 Jane St. (*S. 1932*)

♂HENRY, Thomas Haliburton, B.Sc., (McGill '14), Asst. Engr., Harbour Commrs. of Montreal, 357 Common St., Montreal, Que. (*H*) Apt. 29, 4560 St. Catherine St. W. (*Jr. 1922*) (*A.M. 1927*)

♂HENSHAW, Freo. Robt., Major, R.C.E., (R.M.C., Kingston '11), M.D. No. 6, Halifax, N.S. (*A.M. 1925*)

HEPINSTALL, R. R., B.Sc., (Queen's '14), Pres., R. R. Hepinstall Inc., 601 Market St., New Orleans, La. (*H*) 1205 State St. (*S. 1914*) (*A.M. 1919*)

HERBERT, A. C., B.Sc., (Alta. '35), R.C.C.S. Officers' Mess, Camp Borden, Ont. (*H*) Wilkie, Sask. (*S. 1935*)

♂HERBISON, Robt. M., Hydraulic Engr., Glenfield & Kennedy Ltd. (*H*) 75 Barnweil Rd., Kilmarnock, Scotland. (*A.M. 1926*)

HERBISON, Wm., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 167–8th Ave., Lachine, Que. (*A.M. 1935*)

HERD, Chas. E., Mech. Engr., Hydraulic Dept., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 4110 Oxford Ave., Montreal, Que. (*A.M. 1920*)

HERR, Arthur George, Chief Dftsman., Packard Electric Co. Ltd., St. Catharines, Ont. (*H*) 131 York St. (*A.M. 1935*)

†HERRIOT, Geo. H., B.Sc., (Queen's '07), D.L.S., M.L.S., A.L.S., Asst. Prof., Dept. of C.E., University of Manitoba, Winnipeg, Man. (*H*) 325 Waverly St. (*A.M. 1910*) (*M. 1919*)

HERRMANN, Geo. E., Canada Creosoting Co. Ltd., P.O. Drawer 2408, N., Vancouver, B.C. (*Affil. 1927*)

HERSHFIELD, Chas., B.Sc., (Man. '30), Engr., Standard Iron and Steel Wks., 3402 Dundas St. W., Toronto, Ont. (*H*) 352 Victoria St. (*Jr. 1935*)

♂HERTZBERG, Chas. S. L., Lt.-Col., M.C., (Tor. '05), Harkness & Hertzberg, Rms. 620-622 Bloor Bldg., 57 Bloor St. W., Toronto, Ont. (*H*) 9 Barton Ave. (*A.M. 1911*) (*M. 1917*) (*Member of Council, E.I.C.*)

HESLOP, Wilfrid Gibson, B.A.Sc., (Tor. '30), Res. Engr., Dept. of Nor. Development, Box 2776, Timmins, Ont. (*H*) 74 Winnipeg Ave., Port Arthur, Ont. (*A.M 1935*)

HEUPERMAN, Fred. Justimus, D.L.S., A.L.S., Engr., Can. Western Natural Gas, Light, Heat and Power Co. Ltd., Calgary, Alta. (*H*) 211–6th Ave. N.E. (*A.M. 1925*)

HEWARD, F. S. B., B.Sc., (McGill '12), Pres., F. S. B. Heward & Co. Ltd., 661 New Birks Bldg., Montreal, Que. (*H*) 1541 St. Mark St. (*A.M. 1923*)

HEWITT, Harold L., B.A.Sc., (Tor. '27), Dept Northern Development, North Bay, Ont. (*H*) Apt. 4, Colgan Block. (*Jr. 1927*)

HEWITT, Robert, B.A.Sc., (Tor. '35), Asst. Res. Engr., Dufferin Paving Co. Ltd., Kenora, Ont. (*H*) 56 Roncesvalles Ave., Toronto, Ont. (*S. 1933*)

HEWSON, Ewart G., Engr. Mtce. of Way, C.R., C.N.R., 433 Union Sta., Toronto, Ont. (*H*) 41 Hewitt Ave. (*S. 1907*) (*Jr. 1914*) (*M. 1917*)

HEWSON, Jos. Seldon, B.Sc., (N.S.T.C. '24), Gen. Contr., 1201 Architects Bldg., Montreal, Que. (*H*) 4889 Grosvenor Ave. (*A.M. 1932*)

HEWSON, William Geale, B.A.Sc., (Tor. '03), Asst. Mgr., Hamilton Street Rly., 18 Wentworth St. N., Hamilton, Ont. (*H*) 125 Aberdeen Ave. (*M. 1920*)

HEYGATE, Harold J., Director, The Warden Bay Estate Ltd., Leysdown, Isle of Sheppey, Kent, England. (*H*) Warden Lodge, Leysdown. (*S. 1906*) (*A.M. 1911*)

♂HEYWOOD, Herbert P., Gen Supt., Gee, Walker & Slater Ltd., Contrs., 32 James St., London, England. (*H*) 2 Rosebery Ave., Lincoln, England. (*Jr. 1917*) (*A.M. 1920*)

HIBBARD, F. H., Chief Engr., Quebec Central Rly., Sherbrooke, Que. (*H*) 59 Quebec St. (*S. 1909*) (*Jr. 1912*) (*A.M. 1919*)

HICKS, Ben. C., B.Sc., (McGill '27), Elec. Engr., Shawinigan Water and Power Co., 2131 Orleans Ave., Montreal, Que. (*H*) 3455 Prudhomme Ave. (*S. 1921*) (*Jr. 1928*) (*A.M. 1935*)

HIGGINS, Edgar Clarence, Asst. Engr., H.E.P.C. of Ont., Torodto, Ont. (*H*) 2100 Gerrard St. E. (*Jr. 1921*)

HIGGINS, Frank Chipman, B.Sc., (Acadia '14), Sq. Ldr., R.C.A.F., Dept. National Defence, Ottawa, Ont. (*H*) 105 Brighton Ave. (*A.M. 1920*)

HIGGINS, Thomas Jas., Address unknown. (*Jr. 1923*)

HILL, Burton M., M.P., B.Sc., (N.B. '07), Man'g. Dir., Consolidated Diversified Standard Securities, Rm. 805, 414 St. James St., Montreal, Que. (*S. 1907*) (*A.M. 1912*) (*M. 1919*)

HILL, G. Rixon, a/Asst. Engr., Dept. National Defence, Nakina, Ont. (*H*) Box 278, Virden, Man. (*Jr. 1917*) (*A.M. 1931*)

HILL, Stanley C., B.Sc., (McGill '21), Protection Engr., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 4383 Girouard Ave. (*S. 1919*) (*A.M. 1930*)

HILLIER, Cecil H., B.Sc., (Queen's '34), Asst. to Mech. Supt., Kellogg Co. of Canada, London, Ont. (*H*) 496 Quebec St. (*S. 1933*)

♂HILLMAN, Daniel, Lieut.-Col., D.S.O., Dist. Engr., C.P.R., Rm. 148, Windsor Sta., Montreal, Que. (*H*) 157 Ballantyne Ave. N., Montreal West, Que. (*M. 1914*)

HILTON, Leonard A., B.Sc., (Queen's '29), Elec. Engr., H.E.P.C. of Ont., Niagara Falls, Ont. (*H*) 2335 Dunn St. (*S. 1928*)

HINCHLIFFE, Jos. E., B.Sc., (McGill '26), Dftsman., Hamilton Bridge Co. Ltd., Hamilton, Ont. (*H*) R.R. 2, Mono Road, Ont. (*S. 1924*) (*Jr. 1928*) (*A.M. 1934*)

HINTON, Eric, Hydraulic Engr., International Power and Paper Co., Deer Lake, Nfld. (*Jr. 1932*)

HINTON, Robert E., B.Sc., (Queen's '13), Asst. Engr., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 526 Homewood Ave. (*Jr. 1919*) (*A.M. 1925*)

♂HOBBS, Wilfrid E., Capt., D.L.S., M.L.S., Surveyor, Land Dept., Hudson's Bay Co., 93 Main St., Winnipeg, Man. (*H*) Lot 59, Kildonan R.R. 4. (*S. 1910*) (*Jr. 1912*) (*A.M. 1919*)

♂HODGINS, A. E., Lt.-Col., (R.M.C., Kingston), 1471 Fairfield Rd., Victoria, B.C. (*A.M. 1887*) (*M. 1904*) (*Life Member*)

HODGSON, Jos. Pollard, Partner, Hodgson, King & Marble, Engrs. and Contractors, 1401 Main St., Vancouver, B.C. (*H*) 402 Brand St. (*A.M. 1916*) (*M. 1919*)

♂HODSDON, Donald Wilbur, Lieut., B.C.L.S., Res. Engr., P.G.E. Rly., Squamish, B.C. Address: c/o Assoc. of Prof. Engrs. of B.C., 930 Birks Bldg., Vancouver, B.C. (*A.M. 1919*)

♂HOGARTH, Bruce Bowers, B.A.Sc., (Tor. '14), Engr., Water Power and Water Rights, Dept. of Mines and Nat. Res., Man., Legislature Bldg., Winnipeg, Man. (*H*) 366 Brock St. (*S. 1913*) (*Jr. 1915*) (*A.M. 1919*)

♂HOGARTH, C. Earle, Lieut., B.A.Sc., (Tor. '15), Sales Engr., Toronto Iron Works, Ltd., 629 Eastern Ave., Toronto, Ont. (*H*) 74 Caroline St. E., Burlington, Ont (*S. 1914*) (*Jr. 1916*) (*A.M. 1919*)

HOGARTH, George, (Tor. '09), O.L.S., Mfrs.' Agent, 514 Markham St., Toronto, Ont. (*Jr. 1911*) (*A.M. 1913*) (*M. 1918*)

HOGG, Sidney, Designing Engr., Saint John Drydock Co. Ltd., Saint John, N.B. (*H*) 173 Princess St. (*A.M. 1931*)

HOGG, Thos H., D.Eng., '27, B.A.Sc., C.E., (Tor. '07), Chief Hydraulic Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) R.R. No. 2, Station K. (*S. 1904*) (*A.M. 1912*) (*M. 1922*)

♂HOLDCROFT, John Barber, Lieut., Engr. and Asst. Mgr., Pacific Coast Pipe Co. Ltd., 1551 Granville St., Vancouver, B.C. (*H*) 832 Cumberland Crescent. (*Jr. 1912*) (*A.M. 1913*)

HOLDEN, John C., (R.M.C., Kingston '96), Dist. Engr., C.P.R., Winnipeg, Man. (*H*) 111 Gerard St. (*A.M. 1908*) (*M. 1919*)

HOLDEN, J. Hastie, B.Sc., (McGill '23), Sales Mgr., Geo. W. Reed & Co. Ltd., 4107 Richelieu St., Montreal, Que. (*H*) 4335 Montrose Ave., Westmount, Que. (*S. 1921*) (*Jr. 1930*)

HOLDEN, Otto, B.A.Sc., (Tor. '13), Asst. Hydraulic Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) R.R. No. 2, York Mills, Ont. (*A.M. 1921*)

HOLDER, A. S., B.Sc., (N.S.T.C. '34), Can. Industries Ltd., Shawinigan Falls, Que. (*H*) 61 Maple Ave. (*S. 1931*)

HOLDER, George Wm., Mgr., Abitibi Power and Paper Co., Sturgeon Falls, Ont. Box 306. (*Jr. 1921*) (*A.M. 1930*)

HOLE, John, Cons. Engr. and Arch., 305 Harbour Commrs. Bldg., Toronto, Ont. (*A.M. 1923*) (*M. 1931*)

HOLE, W. G., B.Sc., (Alta. '33), 9421–108 A Ave., Edmonton, Alta. (*S. 1932*)

HOLGATE, W. T., B.Sc., (Alta. '30), Sales Engr., Can. Gen. Elec. Co. Ltd., 214 King St. W., Toronto, Ont. (*H*) 103 Strathmore Blvd. (*Jr. 1931*)

♂HOLLAND, Albert, Lieut., 10 John's Rd., Queen's Park, Chester, England. (*S. 1908*) (*A.M. 1915*)

♂HOLLAND, Franklin E., Lieut., C.E., (Cornell '12), Sales Engr., Sherwin Williams Co. of Canada, Ltd., Montreal, Que. (*H*) 2182 Lincoln Ave. (*A.M. 1922*)

HOLLAND, Trevor, B.Eng., (McGill '32), Plant Engr., Brandram-Henderson Co., Montreal, Que. (*H*) 3749 The Boulevard, Westmount, Que. (*S. 1929*)

HOLLINGWORTH, Wilfrid, Pres. and Mgr., Hamilton Contracting Co. Ltd., 506 Imperial Bldg., Hamilton, Ont. (*H*) 180 Hillcrest Ave. (*A.M. 1909*) (*M. 1914*)

♂HOLLOWAY, Edward S., B.Sc., (McGill '08), i/c Surveys, Dr. F. A Gaby, 608 University Tower Bldg., Montreal, Que. (*H*) 461 Grosvenor Ave., Westmount, Que. (*S. 1905*) (*A.M. 1910*) (*M. 1928*)

HOLMAN, Clive W., Technical and Commercial High School, Sault Ste Marie, Ont. (*H*) 152 Kohler Ave. (*A.M.* 1934)

HOLMES, Arch. R., B.Eng., (King's '95), 360 Lytton Blvd., Toronto, Ont. (*S. 1895*) (*A.M. 1901*) (*M. 1919*)

HOLMES, J. R., B.Sc., (McGill '29), Sales Engr., Robbins & Myers of Canada, Ltd., 1106 Beaver Hall Hill, Montreal, Que. (*H*) 11-A Querbes Ave. (*S. 1929*)

HOLT, Sir Herbert S., D.C.L., LL.D., Chairman, Montreal Light, Heat and Power Cons., Montreal, Que. (*H*) 1459 Stanley St. (*A.M. 1889*) (*M. 1889*)

HOOD, G. Leslie, B.Sc., (Man. '32), Howey Gold Mines Ltd., Red Lake, Ont. (*H*) Glen Ewen, Sask. (*S. 1930*)

HOOPER, Wm. Henry, (McGill '27), Canada Wire and Cable Co. Ltd., Leaside, Ont. (*H*) 17 Macnaughton Rd. (*S. 1928*) (*Jr. 1929*)

♂HOOVER, Owen Hugo, B.A.Sc., (Tor. '12), Engr. i/c., Dom. Water Power and Hydrometric Bureau, Dept. Inter., Public Bldg., Calgary, Alta. (*H*) 1411–4th-A St. N.W. (*A.M. 1921*) (*M. 1935*)

†HOPKINS, Marshall W., Private Practice, St. Paul de Metis, Alta. (*S. 1887*) (*A.M. 1891*) (*M. 1901*) (*Life Member*)

HOPPER, Alfred Edward, Alonzo Ave., Highland Park, Westboro, Ont. (*M. 1923*)

HORNFELT, Harvey A., B.A.Sc., (Tor. '35), H.E.P.C. of Ont., Fraserdale, Ont (*H*) 45 Sussex Ave., Toronto, Ont. (*S. 1935*)

HORSFALL, Herbert, Pres. and Man'g. Dir., Canada Wire and Cable Co., Box 518, Toronto, Ont. (*H*) 126 Forest Hill Rd. (*A.M. 1918*) (*M. 1921*)

♂HOSHAL, Geo. C., Lieut., B.A.Sc., (Tor. '10), Estimating Engr., Wells & Gray, Ltd., 703 Confederation Life Bldg., Toronto, Ont. (*H*) 492 Windermere Ave. (*S. 1907*) (*A.M. 1913*)

HOUGH, Ayton Lloyd, B.Eng., (McGill '33), Cascade Inn, Shawinigan Falls, Que. (*S. 1933*)

HOUGHTON, John R., B.Eng., (McGill '35), Northern Electric Co. Ltd., Montreal, Que. (*H*) 730 Upper Belmont Ave., Westmount, Que. (*S. 1935*)

♂HOUGHTON, John William, Lieut., Gen. Sales Engr., C. A. V. Bosch Ltd., Warple Way, Acton, London, W.3. (*H*) "Arlington," Allandale Ave., Finchley, London, N.3. (*A.M. 1919*)

HOUGHTON, T. Walter, B.Eng., (McGill '32), Howard Smith Paper Mills Ltd., Beauharnois, Que. (*H*) 730 Upper Belmont Ave., Westmount, Que. (*S. 1931*)

HOUGHTON, Walter Craig, (R.M.C., Kingston), Lieut., R.C.O.C., H.Q., M.D. No. 10, Winnipeg, Man. (*S. 1934*)

HOULDEN, J. W., B.Sc., (Queen's '27), Ballistic Engr., Can. Industries Ltd., Brownsburg, Que. (*S. 1927*) (*Jr. 1929*)

♂HOULISTON, John (q), Lt.-Col., D.S.O., 12 Park Rd., Rockcliffe Park, Ottawa, Ont. (*S. 1898*) (*A.M. 1900*)

HOUSTON, Gavin N., C.E., Supt., Oper. and Mtce, Dept. Nat. Res., C.P.R., Galt Mines Bldg., Lethbridge, Alta. (*H*) 1018-1st Ave. S. (*M. 1914*)

HOVEY, L. M., B.Sc., (McGill '25), Asst. Elec. Engr., Winnipeg Electric Co., 1010 Electric Rly. Chambers, Winnipeg, Man. (*H*) 836 Dorchester Ave. (*S. 1921*) (*A.M. 1931*)

HOWARD, Albert Warren, B.A.Sc., (Tor. '35), 2132 Hope St., Calgary, Alta. (*S. 1931*)

HOWARD, L. J. M., Supt'g. Engr., Beechwood Cemetery Co., 202 Beechwood Ave., Rockcliffe Park, Ottawa, Ont. (*A.M. 1917*)

HOWARD, Rupert Fortescue, B.Sc., (McGill '01), Mgr., Power Sales, Gatineau Power Co., 140 Wellington St., Ottawa, Ont. (*H*) 377 Daly Ave. (*M. 1922*)

G. †HOWARD, Stuart, Major, Apt. 3, 456 Pine Ave. W., Montreal, Que. (*M. 1887*) (*Life Member*)

HOWE, Clarence Decatur, The Hon., B.Sc., (M.I.T. '07), Minister of Railways and Canals and Minister of Marine; Man'g. Partner, C. D. Howe & Co., 707 Whalen Bldg., Port Arthur, Ont. (*M. 1922*)

HOWE, H. B., E. Long Engineering Wks., Orillia, Ont. (*H*) West Shefford, Que. (*S. 1935*)

HOWE, Lawrence McLean, B.Sc., (Man. '33), M.Eng., (McGill '35), Operator, Sask. Power Comm., 1739 Cornwall St., Regina, Sask. (*S. 1932*)

HOWORTH, John, 100 Elm Park Rd., Winnipeg, Man. (*S. 1930*)

HOWRIGAN, Clyde P., Supt. of Excav., Aluminum Co. of Canada, c/o Demerara Bauxite Co., McKenzie, British Guiana. (*H*) Bakersfield, Vt. (*A.M. 1917*)

♂HUBBARD, Edward Beane, B.A.Sc., (Tor. '25), H.E.P.C. of Ont., 620 University Ave., Toronto 2, Ont. (*H*) 461 Parkside Drive. (*S. 1920*) (*A.M. 1927*)

HUBBARD, Frederick William, Engr., Dom. Construction Co., 101 Catharine St. So., Hamilton, Ont. (*H*) 127 Fairleigh Ave. So. (*A.M. 1919*)

♂HUDSON, Arthur Magennis, Capt., Dept. of Northern Development, 3502 Parliament Blgs., Toronto, Ont. (*A.M. 1935*)

HUESTIS, Harry E., B.A.Sc., (McGill '96), Asst. Gen. Mgr. and Chief Engr., Quebec Harbour Commrs., Quebec, Que. (*A.M. 1905*)

HUGGARD, J. Harold, B.Sc., (N.B. '35), Norton, Kings Co., N.B. (*S. 1935*)

HUGGINS, Mark Wm., M.A.Sc., (Tor. '33), Engr., E. P. Muntz Ltd., Box 357, Dundas, Ont. (*H*) 246 Lisgar St., Toronto, Ont. (*Jr. 1935*)

♂HUGHES, Chester Arthur, M.A.Sc., (Tor. '22), Asst. Prof. of Strl. Engrg., Univ. of Minnesota, Experimental Engrg. Bldg., Minneapolis, Minn. (*Jr. 1921*) (*A.M. 1930*)

♂HUGHES, Edward, 2nd Lieut., Mayerthorpe, Alta. (*Jr. 1917*) (*A.M. 1921*)

♂HUGHES, Henry Thoresby, Brig.-Gen., C.M.G., D.S.O., Chief Engr., Canadian Battlefields Memorials Comm. (*H*) East Saanich Rd., Royal Oak, V.I., B.C. (*A.M. 1899*) (*M. 1925*)

HUGHES, Jas. W., Elec. Engr., C.P.R., Rm. 903, Windsor Sta., Montreal, Que. (*H*) Apt. 4, 1420 Bernard Ave. W. (*A.M. 1924*)

HUGHES, Philip Bernard, B.Sc., (McGill '26), The Plessisville Foundry, 714 St. James St. W., Montreal, Que. (*S. 1927*)

HUGHSON, H. G., B.Sc., (N.B. '32), Petitcodiac, N.B. (*S. 1932*)

♂HUGHSON, John Ward, Capt., B.Sc., (McGill '12), Mgr. and Sec.-Treas., W. C. Hughson & Sons, Ltd., 707 Hope Chambers, Ottawa, Ont. (*H*) 293 Stewart St. (*A.M. 1921*)

♂HUGHSON, William R., B.A., B.Sc., (Queen's '17), 100 Glen Ave., Ottawa, Ont. (*A.M. 1921*)

♂HUGLI, Edwin E. H., B.A.Sc., (Tor '14), Asst. Strl. Designing Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 356-A Kingswood Rd. (*S. 1913*) (*Jr. 1920*) (*A.M. 1923*)

HULBERT, Edward, B.Sc., (Man. '31), Lieut., R.C.S., Dist. Signal Officer, M.D. 13, Calgary, Alta. (*H*) Bethany, Man. (*S. 1931*)

HULL, Roland S., B.Sc., (N.S.T.C. '32), 194 Reid St., Peterborough, Ont. (*H*) P.O. Box 72, Woodstock, N.B. (*S. 1931*)

HULME, Gordon D., B.Sc., (McGill '31), Shawinigan Water and Power Co., Montreal, Que. (*H*) 3411 Grey Ave. (*S. 1928*)

♂HUMBLE, Archibald Marshall, Capt., Designing Dftsman., Toronto Harbour Commrs., Harbour St., Toronto, Ont. (*H*) 25 Bingham Ave. (*A.M. 1930*)

♂HUME, D. C. M., Squadron Leader, R.C.A.F., Camp Borden, Ont. (*A.M. 1923*)

HUMPHREYS, Jas. John, Chief Engr., Gas Dept., Montreal L.H. and P. Cons., Montreal, Que. (*H*) Apt. B-35, Trafalgar Apts., The Boulevard. (*M. 1929*)

HUMPHRIES, Geo. Edward, Edwards Gold Mines, Ltd., Lochalsh, Algoma, Ont. (*Jr. 1930*)

HUNGERFORD, Samuel James, Pres., C.N.R., 355 McGill St., Montreal, Que. (*M. 1919*)

HUNT, Albert Brewer, B.A.Sc., (Tor. '28), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 5275 Cote St. Luc Rd. (*S. 1926*) (*Jr. 1931*)

HUNT, Edward Victor, B.Sc., (Man. '31), Can. Gen. Elec. Co. Ltd., Davenport Wks., Toronto, Ont. (*H*) 240 Rushton Rd. (*S. 1928*) (*Jr. 1934*)

HUNT, John, B.Sc., (St. Andrews '27), Chief Mech. Engr., Falconbridge Nickel Mines, Falconbridge, Ont. (*Jr. 1930*)

HUNT, Walter George, B.Sc., (C.E.), (McGill '17), Pres. and Man'g. Dir., Walter G. Hunt Co., Ltd., 1405 Bishop St., Montreal, Que. (*H*) 5178 Cote St. Antoine Rd. (*S. 1916*) (*Jr. 1919*) (*A.M. 1922*) (*M. 1932*)

♂HUNT, William Henry, Major, M.C., Ruddock Cottage, Witton Park, Blackburn, Lancs., England. (*A.M. 1910*) (*M. 1925*)

HUNT, Wm. M., B.Sc., (N.S.T.C. '33), Maritime Tel. and Tel. Co. Ltd., Halifax, N.S. (*H*) 39 Spring Garden Rd. (*S. 1934*)

HUNTER, James Henderson, Gen. Supt. and Chief Engr., Canada Starch Co., Montreal, Que. (*H*) 731 Upper Belmont Ave., Westmount, Que. (*A.M. 1908*) (*M. 1923*)

HUNTER, John Wm., B.Sc., (McGill '96), 81 Gore St., Kingston, Ont. (*A.M. 1907*)

HUNTER, Lionel McL., Roadway Engr., City Engr.'s Dept., Corp. of City of Ottawa, Ottawa, Ont. (*H*) 7 Willard Ave. (*Jr. 1913*) (*A.M. 1932*)

♂HUNTER, Wm. Howard, Capt., B.A.Sc., (Tor. '20), Supt., The Foundation Co., of Canada, 1538 Sherbrooke St. W., Montreal, Que. (*A.M. 1922*)

HURDLE, Harold Lancelot, B.Sc., (Alta. '33), Calgary Power Co. Ltd., 107 Commercial Bldg., Edmonton, Alta. (*H*) 16 Tipton Blk. (*S. 1933*)

HURST, Wm. D., B.Sc., (Man. '30), Asst. Engr., i/c Waterworks, City of Winnipeg, 223 James Ave., Winnipeg, Man. (*H*) 78 Queenston St. (*S. 1927*) (*A.M. 1935*)

HURST, Wm., Pres. and Mgr., Hurst Engineering and Construction Co. Ltd., 101 Hurst Block, Winnipeg, Man. (*H*) 74 Ethelbert St. (*Affil. 1928*)

HURTUBISE, J. E., B.A., I.C., B.Sc.A., 340 Kensington Ave., Westmount, Que. (*S. 1934*)

HURTUBISE, Louis, B.A.Sc., c/o Johnson & Ward, Royal Bank Bldg., Montreal, Que. (*S. 1903*) (*A.M. 1909*)

HUSSEY, Erwin H., (Maine '07), Pres., Kemide Mfg. Co. Inc., Port Kennedy, Pa. (*H*) 76 Hillside Rd., Strafford, Pa. (*M. 1923*)

♂HUTCHESON, Walter B., Lieut., Dist. Engr., Dept. of Northern Development, Fort Frances, Ont. (*Jr. 1916*) (*A.M. 1920*)

HUTCHINS, F. M., 3524 Ontario Ave., Montreal, Que. (*S. 1925*)

HUTCHINSON, W. J. B., B.Sc., (McGill '30), Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) Apt. 14, 5880 Cote St. Antoine Rd. (*S. 1928*)

HUTCHISON, Alexander, B.Sc., (Glasgow), Vice-Pres., Drummond, McCall & Co., Ltd., 930 Wellington St., Montreal, Que. (*H*) 4294 Montrose Ave., Westmount, Que. (*S. 1908*) (*A.M. 1914*)

HUTCHISON, David, B.Sc., (Queen's '24), Constrn. Supt., Power Corp. of Canada, 355 St. James St., Montreal, Que. (*H*) 49 Joyce Ave., Outremont, Que. (*A.M. 1932*)

HUTTON, John R., B.Sc., (N.S.T.C. '27), Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) Apt. 20, 123 Bold St. (*S. 1925*)

♂HUTTON, L. A. B., Supt. of Communications, C.P.R., Sudbury, Ont. (*H*) 48 Roxboro Drive. (*A.M. 1922*)

HYDE, Arthur E., 101 Newlands Ave., Hamilton, Ont. (*S. 1934*)

HYLLAND, Einar N., C.E., (Trond. '29), Designer, Beauharnois L.H. and P. Co., P.O. Box 50, Beauharnois, Que. (*Jr. 1930*)

HYMAN, H. Davidson, B.Sc., (McGill '25), Wks. Engr., J. R. Booth Ltd., Ottawa, Ont. (*H*) 120 Sunnyside Ave. (*Jr. 1926*)

HYMMEN, Edmond B., M.A.Sc., Babcock-Wilcox & Goldie-McCulloch Ltd., Galt, Ont. (*H*) 125 Blair Rd. (*S. 1930*)

HYNDMAN, Walter Eardley, Dist. Engr., D.P.W., Canada, Charlottetown, P.E.I. (*H*) 25 Fitzroy St. (*M. 1924*)

IDSARDI, Harold, B.Sc., (McGill '05), Engr., Mech. Dept., McIntyre Porcupine Mines, P.O. Box 2363, Timmins, Ont. (*S 1902*) (*A.M. 1910*)

INGHAM, J. H., B.Eng., (McGill '35), Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 4034 Dorchester St. W., Westmount, Que. (*S. 1933*)

♂INGLES, Chas. Jas., Col., D.S.O., V.D., 393 Parkside Drive, Toronto, Ont. (*A.M. 1909*)

INGLES, Chas. L., B.Sc., (Queen's '34), Lieut., R.C.E., M.D 13, Calgary, Alta. (*S. 1932*)

INGS, Jasper H., B.A.Sc., (Tor. '25), (C.E. '31), Foreman, i/c Project 90, Dept. National Defence, Emsdale, Ont. (*H*) Charlottetown, P.E.I. (*S. 1920*) (*Jr. 1927*) (*A.M. 1930*)

INNES, E. P. N., B.Eng., (McGill '34), 56 Charlton Ave. W., Hamilton, Ont. (*S. 1935*)

IRETON, Jos. Maurice, B.Sc., (Queen's '28), Calgary Technical High School, Calgary School Bd. Address, 536-15th Ave. W., Calgary. Alta. (*Jr. 1929*) (*A.M. 1932*)

♂IRVINE, Frederick, Engr. Sub-Lieut., Asst. Engr., F. S. B. Heward & Co. Ltd., 661 New Birks Bldg., Montreal, Que. (*H*) 4568 Draper Ave. (*A.M. 1922*)

♂IRVINE, Joseph Holmes, Capt., B.Sc., (Man.), Designing Engr., City of Ottawa, Transportation Bldg., Ottawa, Ont. (*H*) 236 Holmwood Ave. (*S. 1911*) (*A.M. 1917*)

†IRVING, T. T., B.Sc., (McGill '98), Chief Engr., Central Region, C.N.R., 436 New Union Sta., Toronto 2, Ont. (*H*) 625 Avenue Rd. (*S. 1898*) (*A.M. 1902*)

♂IRWIN, Gifford Melville, Lieut., B.Sc., (McGill '19), B.C.L.S., City Engr. and Water Commr., City of Victoria, City Hall, Victoria, B.C. (*H*) 321 Robertson St. (*M. 1935*)

IRWIN, Karl Webster, M.A.Sc., C.E., Asst. Toll Engr. (C.N. Div.), Bell Telephone Co. of Canada, Toronto, Ont. (*H*) 23 Elmsthorpe Ave. (*S. 1923*) (*Jr. 1928*)

JACK, Grant R., Commr. of Works, The Corp. of the Township of East York, 443 Sammon Ave., Toronto 6, Ont. (*H*) 787 Coswell Ave. (*A.M. 1918*)

♂JACKSON, Arthur, Lieut., B.Sc., (Queen's '16), Assoc. Prof. of Drawing, Queen's University, Kingston, Ont. (*H*) 317 King St. W. (*A.M. 1920*)

JACKSON, Carl Henry, B.Sc., (McGill '21), Engr., Can. Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 2317 Wilson Ave. (*S. 1921*) (*Jr. 1923*) (*A.M. 1934*)

JACKSON, Charles H., B.A.Sc., (Tor. '23), Prod. Mgr., Ammun. Divn., Can. Industries Ltd., Brownsburg, Que. (*Jr. 1928*) (*A.M 1935*)

JACKSON, John E., 35 Cromwell Rd., London, S.W., England. (*S. 1929*)

JACKSON, John H., O.L.S., 621 Ellis St., Niagara Falls, Ont. (*S. 1899*) (*A.M. 1905*) (*M. 1932*)

JACKSON, K. A., B.Sc., (Alta. '32), (M.Sc. '34), Taylor & Pearson Ltd., Edmonton, Alta. (*H*) 10039-106th St., Edmonton, Alta. (*S. 1932*)

JACKSON, Walter, B.A.Sc., (Tor. '09), Dist. Civil Engr., H.E.P.C. of Ontario, Box 237, Niagara Falls, Ont. (*H*) 700 Eastwood Crescent. (*S. 1907*) (*A.M. 1913*) (*M. 1923*) (*Member of Council, E.I.C.*)

JACKSON, William, Apt. 1, 895 Dollard Ave., Outremont, Que. (*A.M. 1928*)

JACOBS, Lionel Leslie, Pres., Electrol Inc., 934 Main Ave., Clifton, N.J. (*H*) Sunnylands, Little Silver, N.J. (*A.M. 1919*)

JACOBS, Llewellyn C., B.A., (Man., '05), Constrn. Mgr., Power Corp. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 146 Wolseley Ave., Montreal West, Que. (*S. 1908*) (*Jr. 1911*) (*A.M. 1912*) (*M. 1921*)

JACOBS, Milton, Chief Engr., Brown Co., Berlin, N.H. (*H*) 162 Washington St. (*M. 1931*)

JACOBSEN, E. R., B.Sc., (McGill '29), (M.Eng. '32), Dom. Bridge Co. Ltd., Lachine, Que. (*S. 1928*)

♂JAMES, David Harries, Indust. Engrg. Dept., Canadian Vickers, Ltd., Montreal, Que. (*H*) 1036 Laurier Ave. West. (*A.M. 1926*)

♂JAMES, Edward Henry, Lieut., Partner, A. D. Swan, Cons. Engr., 1188 Phillips Place, Montreal, Que. (*H*) 1541 Sherbrooke St. W. (*A.M. 1921*) (*M. 1926*)

JAMES, Eric W. M., Highway Commr's Office, Parliament Bldgs., Winnipeg, Man. (*H*) 255 Balfour Ave. (*S. 1909*) (*A.M. 1913*)

JAMES, Harold H., Dftsman., Canada Creosoting Co., Royal Bank Bldg., Toronto, Ont. (*H*) 368 Shaw St. (*A.M. 1924*)

JAMES, William Atlee, Asst. Chief Engr., C.P.Ry., Winnipeg, Man. (*H*) Lydiatt, Man. (*M. 1909*) (*Life Member*)

G.†JAMIESON, James A., Cons. Engr., Board of Trade Bldg., Montreal, Que. (*H*) 268 Wood Ave., Westmount, Que. (*M. 1903*) (*Life Member*)

♂JAMIESON, Robert Edwards, Lieut., M.Sc., (McGill '20), Prof. of C.E., McGill University, Montreal, Que. (*H*) 234 Metcalfe Ave., Westmount, Que. (*A.M. 1921*) (*M. 1932*)

JAMIESON, Wm., (Liverpool '95), Box 414, Powell River, B.C. (*M. 1925*)

JAMIESON, Wm. T., Asst. Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 3821 Hampton Ave. (*Jr. 1912*) (*A.M. 1918*)

JAPP, Sir Henry, K.B.E., Chief Engr. and Wks. Director, John Mowlem & Co., Ltd., 91 Ebury Bridge Rd., London, S.W.1, England (*H*) 10, The Orchard, Bedford Park, London, W.4. (*M. 1914*)

†JAQUAYS, Homer Morton, M.A., M.Sc., (McGill '95), Vice-Pres., Steel Co. of Canada, Ltd., 525 Dominion St., Montreal, Que. (*H*) 3457 Ontario Ave. (*S. 1898*) (*A.M. 1898*) (*M. 1909*)

JAQUAYS, H. M., Jr., B.Sc., Partner, Watson, Jaquays & Co., 300 Shaughnessy Bldg., Montreal, Que. (*H*) 3457 Ontario Ave. (*S. 1931*)

JARAND, Wm. Henry, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4442 Harvard Ave. (*A.M. 1929*)

♂JARDINE, Ernest Ian Walter, Capt., Asst Elec. Engr., B.C. Electric Rly. Co., 425 Carrall St., Victoria, B.C. (*H*) 30 Douglas St. (*A.M. 1920*)

JARMAN, Percy Edward, Gen. Mgr., City of Westmount, City Hall, Westmount, Que. (*H*) 78 Chesterfield Ave., Westmount, Que. (*S. 1909*) (*Jr. 1914*) (*A.M. 1917*)

JARVIS, Gerald W., B.Sc., (Queen's '30), 79 Bold St., Hamilton, Ont. (*S. 1931*)

JEFFREY, Jas. Stewart., B.Eng., (McGill '35), Dom. Oxygen Co., Montreal, Que. (*H*) 2063 Stanley St. (*S. 1935*)

♂JEMMETT, Douglas Mill, Lieut., D.C.M., M.A., B.Sc., (Queen's '13), Prof. Elec'l. Engrg., Queen's University, Kingston, Ont. (*H*) "Elmhurst," Centre St. (*A.M. 1921*)

JENKINS, George Aubrey, B.Sc., (Queen's '09), Dist. Engr., Warren Technical Service Inc., P.O. Box 1869, Boston, Mass. (*S. 1908*) (*Jr. 1911*) (*A.M. 1922*)

JENKINS, Thos. H., B.A.Sc., (Tor. '25), Designing Engr., Bridges and Bldgs., G.T.W. R.R. Co., Detroit, Mich. (*H*) 126 Rosedale Blvd., Sandwich, Ont. (*S. 1922*) (*Jr. 1927*) (*A.M. 1932*)

JENKINS, William Ernest, B.Sc., (Queen's '07), Pres. and Gen. Mgr., Columbia Bitulithic Ltd., Granville Island, B.C. (*H*) 2415 West First Ave., Vancouver, B.C. (*S. 1907*) (*A.M. 1917*)

JENKINSON, J. Hayes, Mgr., Dom. Tar & Chemical Co. Ltd., Sault Ste. Marie, Ont. (*H*) 20 Herrick St. (*A.M. 1922*)

JENNINGS, Geo. Lorne, B.A.Sc., (Tor. '26), Mgr. and Engr., Harry Jennings, 49 St. Clair Ave., West Toronto 5, Ont. (*S. 1926*)

JENNINGS, Michael Wallace, B.Sc., (N.B., '11), Supt of Constrn., Alberta Wheat Pool, 628 Lougheed Bldg., Calgary, Alta. (*H*) 3044-3rd St. W. (*A.M. 1922*)

♂JENNINGS, Percy John, Major, O.B.E., Park Supt., Banff National Park, P.O. Box A, Banff, Alta. (*A.M. 1911*) (*M. 1920*)

♂JENNINGS, Robert Bernard, Major, 4196 Beaconsfield Ave., Montreal, Que. (*A.M. 1921*) (*M. 1926*)

JENSSEN, Lawrence N., Grad. (Trond.), c/o Fraser-Brace Ltd., Montreal, Que. (*H*) Lac Marois, Que. (*A.M. 1904*) (*M 1911*)

JEPSEN, Viggo, Jas. A. Ogilvy's Ltd., Oil-O-Matic Divn., Montreal, Que. (*H*) 1387 Athlone Rd., Town of Mt. Royal, Que. (*Jr. 1932*)

JETTE, Chas. Herve, B.A.Sc., C.E., (Ecole Polytech., Montreal '12), Divn. Engr., Cons. Paper Corp. Ltd., Port Alfred, Que. (*S. 1911*) (*Jr. 1917*) (*A.M. 1918*)

JETTE, J. Arthur, B.A.Sc., Supt. Engr., Canal. Dept., City of Montreal, City Hall. (*H*) 5601 Phillips Ave., Montreal, Que. (*A.M. 1920*) (*M. 1925*)

JEWETT, Frederick C., B.Sc., (McGill '05), 16 Ontario St. S., St. Catharines, Ont. (*S. 1902*) (*A.M. 1910*)

JICKLING, Robert William, B.Sc., E.E., (Man., '20), Operating Supt., Sask. Power Comm., Regina, Sask. (*H*) Ste. 16, Kenora Apts. (*S. 1919*) (*Jr. 1922*) (*A. M. 1931*)

JOHANSEN, A. M., B.Sc., (McGill '29), Mexican Light & Power Co., Apartado 124-bis, Mexico, D.F. (*H*) Shawinigan Falls, Que., Canada. (*S. 1927*)

JOHNS, Chas. F., B.Sc. (Mt. Allison '28), Cons. and Heating-Engr., Enterprise Foundry Co. Ltd., Box 386, Sackville, N.B. (*S. 1924*) (*Jr. 1930*)

JOHNSON, Claude Vernon, Cons. Engr., Rm. 515, 229 St. Joseph St., Quebec, Que. (*H*) 52nd Ave., St. Genevieve. (*S. 1907*) (*A.M. 1910*) (*M. 1918*)

JOHNSON, Edward Preston, Div. Engr., Welland Ship Canal, Dept. Rlys. and Canals, P.O. Box 185, Welland, Ont. (*H*) 9 Elgin St. W. (*S. 1900*) (*A.M. 1909*)

♂JOHNSON, G. Alan, Capt., M.C., B.Sc., (McGill '12), 4103 Sherbrooke St. W., Montreal, Que. (*S. 1912*) (*A.M. 1922*)

♂JOHNSON, Geo. Owen, Wing Cmdr., C.O., R.C.A.F. Station, Dept. National Defence, Trenton, Ont. (*A.M. 1924*)

JOHNSON, John David, Pres. and Gen. Mgr., Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. (*H*) 638 Clarke Ave., Westmount, Que. (*Affil. 1925*)

JOHNSON, J. O., B.Sc., (Sask. '29), Hydrographer, Dept. of Marine, Canada, 319 P.O. Bldg., Victoria, B.C. (*H*) 200 Abed Ave. (*S. 1928*)

JOHNSON, Jas. Richard, B.Eng., (McGill '34), Laurentide Divn., Cons. Paper Corp., Grand'Mere, Que. (*S. 1933*)

JOHNSON, R. E. L., B.Eng., (McGill '32), 536 Grosvenor Ave., Westmount, Que. (*S. 1930*)

JOHNSON, Wm. James, B.Sc., (McGill '23), c/o Johnson Co., Thetford Mines, Que. (*S. 1921*) (*A.M. 1930*)

JOHNSTON, Alex. Chas., Elec. Supt., Aluminum Co. of Canada Ltd., Box 14, Arvida, Que. (*A.M. 1935*)

JOHNSTON, Chas., B.A.Sc., C.E., (Tor. '07), Chief Engr., Dufferin Paving Co., Fleet St., Toronto, Ont. (*H*) 70 Dundas St., Oakville, Ont. (*M. 1918*)

♂JOHNSTON, Clifford M., B.Sc., (Queen's '20), Vice-Pres., Welch & Johnston, Ltd., 474 Bank St., Ottawa, Ont. (*H*) 30 Sunset Blvd. (*S. 1920*) (*Jr. 1923*) (*A.M. 1930*)

♂JOHNSTON, Geo. Wm. Frederick, B.A.Sc., (Tor. '15), Contracting Engr., Watson Jack Co. Ltd., 1106 Castle Bldg., Montreal, Que. (*H*) 4351 Westhill Ave., N.D.G. (*S. 1914*) (*Jr. 1919*) (*A.M. 1922*)

JOHNSTON, Harold Chapman, B.A.Sc., (Tor. '10), Pres. and Mgr., H. C. Johnston Co. Ltd., Contracting Engrs., 751 Victoria Sq., Montreal, Que. (*H*) 241 Lazard Ave., Town of Mt. Royal, Que. (*A.M. 1920*)

♂JOHNSTON, H. Lloyd, Jr., Lieut., M.C., B.Sc., (McGill '27), B.C.L.S., Plant Engr., Canada Paper Co., Box 201, Windsor Mills, Que. (*Jr. 1926*) (*A.M. 1930*)

JOHNSTON, Harold S., B.Sc., (McGill '09), Chief Engr., N.S. Power Comm., Bank of Nova Scotia Bldg., Halifax, N.S. (*H*) 108 Oakland Rd. (*S. 1897*) (*A.M. 1911*) (*M. 1922*) (*Member of Council, E.I.C.*)

JOHNSTON, Jas. Homer, D.L.S., A.L.S., Dist. Engr., P.W.D., Alta., Peace River, Alta. (*A.M. 1932*)

JOHNSTON, John T., B.A.Sc., C.E., (Tor. '10), Director, Dom Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) Apt. 4, 311 Lisgar St. (*S. 1908*) (*A.M. 1912*) (*M. 1917*)

♂JOHNSTON, Wm. Jas., B.Sc., (N.B. '13), Asst. Engr., D.P.W., Canada, P.O. Box 1417, Saint John, N.B. (*H*) 114 Douglas Ave. (*A.M. 1920*)

JOHNSTON, Wm. D., B.A.Sc. (Tor. '35), Dfting. Rm., Dom. Bridge Co. Ltd., Toronto, Ont. (*H*) 583 Vaughan Rd. (*S. 1935*)

JOHNSTONE, Ralph Geo., B.Sc., (N.S.T.C. '24), Asst Prod. Mgr., E. B. Eddy Co., Hull, Que. (*H*) 300 Cooper St., Ottawa, Ont. (*Jr. 1925*) (*A.M. 1930*)

JOHNSTONE, William Morrison, B.Sc., (Queen's '13), Asst. Commr. of Wks., City of Ottawa, 703 Transportation Bldg., Ottawa, Ont. (*H*) 226 Clemow Ave. (*A.M. 1921*)

JOHRE, S. G., Asst. Engr., Public Utilities Comm., London, Ont. (*H*) 153 Kent St. (*A.M. 1934*) (*Sec.-Treas., London Br., E.I.C.*)

JOLLEY, Malcolm P., Lieut., B.Eng., (McGill '33), O.M.E., R.C.O.C., Military College of Science, Woolwich, S.E. 18. Address: Canada House, Trafalgar Sq., London, W.1., England. (*S. 1932*)

JONCAS, J. P. P., B.A.Sc., (Ecole Polytech., Montreal '08), Q.L.S., Cons. Engr., Joncas & Malouin, Quebec Rly. Bldg., Quebec, Que. (*H*) 1216 St. Foye Rd. (*A.M. 1913*)

JONES, A. M. S., B.Sc., (N.B. '34), Anglo Can. Pulp and Paper Co., Malin, Via La Branche, Que. (*H*) R.R. 1, Moncton, N.B. (*S. 1934*)

JONES, Arthur R., B.Sc., (Alta. '28), Designing Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*Jr. 1930*)

♂JONES, Chas. Hugh LePailleur, Col., O.B.E., V.D., Pres. and Mang. Dir., Mersey Paper Co. Ltd., Box 485, Liverpool, N.S. (*H*) Main St. (*M. 1926*)

JONES, Frank P., Pres. Consumers Glass Co. Ltd., Rm. 324, Canada Cement Bldg., Montreal, Que. (*Affil. 1910*)

♂JONES, F. S., Capt., M.C., B.Sc., (N.B., '13), Asst. Engr., Dept. Marine, River St. Lawrence Ship Channel, Sorel, Que. (*H*) 510 Cooper St., Ottawa, Ont. (*A.M. 1919*)

JONES, Harry A., B.Sc., (Sask. '29), Asst. Engr., City Engr.'s Dept., Regina, Sask. (*H*) 1421 Elphinstone St. (*S. 1927*) (*A.M. 1930*)

JONES, H. Cecil, B.Sc., (Man. '26), Lighting Services, Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 66 Harshaw Ave. (*S. 1926*) (*Jr. 1928*)

JONES, Harold Wm., B.Sc., (McGill '03), i/c Tidal Survey Divn., Hydrographic Service, Dept. of Marine, Hunter Bldg., Ottawa, Ont. (*H*) McKellar, Ottawa, Ont. (*S. 1902*) (*A.M. 1910*) (*M. 1922*)

JONES, James Dyer, Vice-Pres. and Gen. Mgr., Algoma Steel Corp., Ltd., Sault Ste. Marie, Ont. (*H*) 977 Queen East. (*M. 1922*)

JONES, J. H. Mowbray, B.A.Sc., (Tor. '27), Chief Engr. and Asst. Gen. Supt., Mersey Paper Co., P.O. Box 483, Liverpool, N.S. (*S. 1925*) (*Jr. 1930*) (*A.M. 1932*)

JONES, Lee Morgan, Warren Bituminous Paving Co., 54 University Ave., Toronto, Ont. (*A.M. 1908*) (*M. 1918*)

JONES, Llewellyn Edward, B.Sc., (Man.), M.A.Sc., (Tor. '33), Dept. of Mech. Engrg., University of Toronto, Toronto, Ont. (*H*) 93 Rosseau Ave., Transcona, Man. (*S. 1929*)

♂JONES, Louis Elgin, Col., C.M.G., D.S.O. and Bar., B.A., (Tor. '11), Mgr., The Can. Ingot Iron Co. Ltd., 35 George St., Guelph, Ont. (*H*) 74 Arthur St. (*M. 1922*)

JONES, Morris Herbert, Dip. in M.E., (Cardiff '12), Mtce. and Constrn. Engr., Ontario Paper Co., Thorold, Ont. (*H*) 48 Monck St., St. Catharines, Ont. (*A.M. 1924*)

♂JONES, Robert Bolton, Lieut., Asst. Engr., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 5421 Grovehill Place. (*A.M. 1928*)

♂JONES, Vernon C., B.Sc., (Queen's '23), C.P.R. Telegraphs, 368 Main St., Winnipeg, Man. (*S. 1922*) (*A.M. 1926*)

JORDAN, J. M., B.A.Sc., (Tor. '34), Fenelon Falls, Ont. (*S. 1934*)

JORON, Rodolphe Emile, B.A.Sc., Q.L.S., Private Practice, Chicoutimi, Que (*A.M. 1925*)

JOSLYN, Cecil Earle, B.Sc., (Queen's '16), D.L.S., Mgr., Land Dept., Hudson's Bay Co., Winnipeg, Man. (*A.M. 1919*)

JOST, B. N., B.S., (Penn. State '34), Guysboro, N.S. (*S. 1930*)

JOST, Edward B., B.Sc., Sr. Hydraulic Engr., Dept. Rlys. and Canals, Ottawa, Ont. (*S. 1902*) (*A.M. 1913*)

JOST, G. B., B Eng., (McGill '32), 3605 University St., Montreal, Que. (*S 1930*)

JOST, Leslie Gordon, B.Sc., (Acadia), B.Sc., (McGill '10), i/c Strl. Dfting Rm., Cons Steel Corp., Box 1348 Arcade Station, Los Angeles, Calif. (*H*. 4850 Haskell Ave., Van Nuys, P.O. (*S. 1909*) (*A.M. 1913*)

JOST, V. A., B.S., (Penn. State '34), Guysboro, N.S. (*S. 1930*)

♂JOY, Clyde B., Lieut., B.A.Sc., (Tor. '24), Foreman, i/c Project 30, Dept. National Defence, Camp Borden, Ont. (*H*) 77 Wembley Drive, Toronto, Ont. (*S. 1920*) (*Jr. 1925*) (*A.M. 1931*)

JOYAL, Jules, B.A.Sc., (Ecole Polytech. Montreal '20), Engr., Quebec Public Service Comm., Court House, Quebec, Que. (*Jr. 1923*) (*A.M. 1925*) (*Sec.-Treas., Quebec Branch, E.I.C.*)

JOYCE, Walter Edward, Ph.B., C.E., (Yale '11), 67 Rico Way, San Francisco, Calif. (*A.M. 1918*)

JUBIEN, Ernest B., B.Sc., (McGill '26), Engrg. Dept., Canadian Industries Ltd., P.O. Box 1260, Montreal, Que. (*H*) 4679 Cote St. Catherine Rd. (*S. 1922*) (*A.M. 1935*)

JUE, Gordon J., B.Eng., (McGill '32), Pui Ching Middle School, Tungshan, Canton, China. (*S. 1930*)

♂JULIAN, Fennell Thompson, B.A.Sc., (Tor. '20), Supt., J. A. Vance, Contractor, Woodstock, Ont. (*H*) 591 King St. (*Jr. 1921*) (*A.M. 1930*)

JUNKINS, Sydney Edwin, B.A., (Dartmouth '87), M.A., (Dartmouth '90), Dr. Engrg., '27), Cons. Engr., President, The Sydney E. Junkins Ltd.; The Sydney E. Junkins Co. B.C., Ltd.; Hanover Engineering and Development Co. Bus. add.: c/o Stein Bros. & Boyce, 39 Broadway, N.Y. Offices: 555 Howe St., Vancouver; Rm. N., Royal Alexandra Hotel, Winnipeg, Man. (*H*) 29 Rope Ferry Rd., Hanover, N.H. (*M. 1913*)

JUPP, Albert E., B.A.Sc., (Tor. '15), O.L.S., Pres. and Mgr., The A. E. Jupp Construction Co., 170 Berkeley St., Toronto, Ont. (*H*) 56 Douglas Drive. (*S. 1907*) (*A.M. 1910*)

JUSTICE, C. W., B.Sc., (Man. '26), Asst. to Plant Engr., Noranda Mines, Ltd., Box 14, Noranda, Que. (*H*) 83 Second Ave. (*S. 1925*) (*Jr. 1929*) (*A.M. 1935*)

KAELIN, Frederick Thomas, M.E., (Fed. Polytech., Zurich), Advisory Engr., Shawinigan Water and Power Co., Montreal, Que. (*H*) 4002 Grey Ave. (*S. 1904*) (*A.M. 1904*) (*M. 1920*)

KANE, Chas. S., Engr., Sales Mgr., E.D., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 73 Wicksteed Rd., Town of Mount Royal, Que. (*Jr. 1920*) (*A.M. 1923*)

KARN, Herbert Christopher, B.A.Sc., (Tor. '16), Power Engr., Engrg. Dept., Can. Industries Ltd., Box 1260, Montreal, Que. (*H*) 4251 Hampton Ave. (*A.M. 1928*)

KATZ, Morris, B.Sc., M.Sc., (McGill '27), Ph.D., '29, Research Chemist, National Research Council, Ottawa, Ont. (*S. 1924*) (*A.M. 1930*)

KAUTH, Carl G., B.Sc., (Queen's '34), Dom. Oxygen Co., 833 Davenport Rd., Toronto, Ont. (*H*) 128 Hilton Ave. (*S. 1934*)

KAY, Alan Geoffrey, 10 Wayagamack Island, Three Rivers, Que. (*S. 1932*)

KAYE, John R., B.Sc., (McGill '24), Pres., Engineering Service Co. Ltd., P.O. Box 713, Halifax, N.S. (*H*) 12 Walnut St. (*S. 1924*) (*A.M. 1932*)

KAYSER, N. J., B.Sc., (Wis. '10), Director and Asst. to the 1st Vice-Pres., Fraser-Brace Engineering Co. Ltd., 10 East 40th St., New York, N.Y. (*M. 1930*)

KAZAKOFF, John, B.Eng., (McGill '35), Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) 13 Montcalm St., Sherbrooke, Que. (*S. 1935*)

KEAN, David Jacques, (Tor. '09), County Engineer, P.O. Box 579, Whitby, Ont. (*A.M. 1920*)

KEARNEY, Graham, B.Sc., (McGill '11), Dist. Mgr., English Electric Co. of Canada Ltd., Rm. 1124, University Tower, Montreal, Que. (*H*) 3465 Cote des Neiges Rd. (*M. 1927*)

KEARNS, James Alfred, B.Sc., (McGill '12), Cons. Engr., Wilson & Kearns, 620 Cathcart St., Montreal, Que. (*H*) 44 Anwoth Rd., Westmount, Que. (*S. 1912*) (*A.M. 1925*)

KEATING, Harold J., B.Sc., (N.S.T.C. '33), 99 Charles St., Halifax, N.S. (*S. 1930*)

KEATING, R. V. H., Res. Engr., Ontario Paper Co. Ltd., Thorold, Ont. (*H*) 4 Thairs Ave., St. Catharines, Ont. (*A.M. 1925*)

†KEAY, Herbert O., B.Sc., (M.I.T. '00), Mgr., Research Lab., Consolidated Paper Corp. Ltd., Three Rivers, Que. (*M. 1909*)

KEENE, T. Ross, B.Sc., (McGill '27), Gen. Traffic Dept., The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 3620 Marlowe Ave. (*S. 1925*)

†KEITH, Fraser Sandeman, B.Sc., (McGill '03), Mgr., Dept. of Development, The Shawinigan Water and Power Co. Ltd., Power Bldg., Montreal, Que. (*H*) P.O. Box 268, Ste Anne de Bellevue, Que. (*S. 1902*) (*A.M. 1909*) (*M. 1921*)

KEITH, Homer P., C.E., (Tor. '07), D.L.S., A.L.S., Deputy Minister, D.P.W., Alta., Edmonton, Alta. (*H*) 10028–89th Ave. (*A.M. 1922*)

KEITH, John B. Clark, B.A.Sc., (Tor. '11), City Comptroller and Gen. Mgr., Windsor Utilities Comm., 607 Canada Bldg., Windsor, Ont. (*H*) 309 Kildare Rd., Walkerville, Ont. (*A.M. 1917*)

KEITH, W. H., B.A.Sc., (Tor. '24), County Engr., County of Wellington, Court House, Guelph, Ont. (*H*) 126 Glasgow St. (*S. 1921*) (*Jr. 1927*) (*A.M. 1928*)

KELLAM, Geo. Douglas, B.Sc., (Man. '33), Can. Western Natural G.L.H. and P. Co., Calgary, Alta. (*H*) 913-5th Ave. W. (*S. 1933*)

KELLY, Edward Arthur, (Tor. '11), Dist. Mgr., Dept. of Northern Development, Kenora, Ont. (*A.M. 1924*) (*M. 1926*)

KELLY, Sydney Foster, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 5 Pointe Claire Ave., Pointe Claire, Que. (*Affil. 1929*)

†KELSCH, R. S. (*q*), Apt. 112, 1227 Sherbrooke St. W., Montreal, Que. (*M. 1898*)

KELSEY, E. S., B.Sc., (Man. '21), M.Eng., (McGill '33), Engr., Northern Electric Co., 1261 Shearer St., Montreal, Que. (*H*) 125-34th Ave., Lachine, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1931*)

♂KEMP, Cecil Geo., Engr. and Constrn. Supt., Consumers Glass Co. Ltd., Ville St. Pierre, Que. (*H*) Apt. 10, 2376 Melrose Ave., N.D.G., Montreal, Que. (*A.M. 1935*)

♂KEMP, J. Colin, Major, D.S.O., M.C., B.A., (Oxon), B.Sc., (McGill '08), Asst to the Pres., Dom. Stores Ltd., 995 Smith St., Montreal, Que. (*H*) 70 Forden Ave., Westmount, Que. (*S. 1907*) (*A.M. 1912*)

♂KENDALL, Herbert Crosby, B.Sc., (Queen's '17), Bldg. and Mech. Supt., Toronto Terminals Rly. Co., 402 New Union Sta., Toronto, Ont. (*H*) 22 Valleyview Gardens. (*A.M. 1921*)

KENNEDY, Duncan, Res. Engr., London County Council, Chelsea Bridge Reconstruction, London, S.W.1, England. (*H*) 16 Queens Rd., Beckenham, Kent. (*A.M. 1926*)

♂KENNEDY, Henry C., Lieut., Montreal Repres., Wm. Kennedy & Sons, Ltd., 112 McGill St., Montreal, Que. (*H*) 40 Edgehill Rd., Westmount, Que. (*S. 1904*) (*A.M. 1910*)

♂KENNEDY, Howard, Capt., M.C., B.Sc., (McGill '14), Mgr., Woodlands Dept., E. B. Eddy Co., Ltd., Hull, Que. (*H*) 275 Springfield Rd., Rockcliffe Park, Ottawa, Ont. (*A.M. 1921*) (*M. 1928*)

KENNEDY, T. Dowsley, Vice-Pres. and Man'g. Dir., The William Kennedy & Sons, Ltd., Owen Sound, Ont. (*H*) 645 Second Ave. W. (*A.M. 1911*)

†KENNEDY, William, Apt. 101, 1469 Drummond St., Montreal, Que. (*M. 1887*) (*Life Member*)

KENNEY, C. L., B.Sc., (N.S.T.C. '29), Clarks Harbour, N.S. (*S. 1930*)

♂KENNY, Walter Robert, D.F.C., Wing Cmdr., Chairman, Dev. Comm., Air Force Station, Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 195 Acacia Ave., Rockcliffe. (*A.M. 1924*)

KENRICK, Robert B., 3525 Vendome Ave., Montreal, Que. (*A.M. 1888*) (*M. 1898*) (*Life Member*)

♂KENSIT, H. E. M., Cons. Engr., 155 Fifth Ave., Ottawa, Ont. (*M. 1914*)

KENT, A. Douglas, 148 Barrie St., Kingston, Ont. (*S. 1935*)

♂KENT, Edward Sherburne, Lieut., B.Sc., (N.S.T.C. '10), Designing Engr., Cowin & Co., Ltd., Pacific and Yeoman Sts., Winnipeg, Man. (*H*) 321 Overdale St. (*A.M. 1918*)

KENT, Geo. E., B.Sc., (N.S.T.C. '28), Asst. Supt., International Petroleum Co., Talara, Peru, S.A. (*S. 1926*) (*A.M. 1934*)

KENT, Wm. Leslie, B.Sc., (Alta. '31), 11444–67th St., Edmonton, Alta. (*S. 1929*)

KENYON, Lot Amos, B.Sc., (McGill '08), Asst. Engr., Elec. Dept., Montreal L.H. and P. Cons., Rm. 310, Power Bldg., Montreal, Que. (*H*) 4926 Mira Rd. (*S. 1908*) (*A.M. 1914*)

KER, Frederick Innes, B.Sc., (McGill '09), Man'g Dir. and Editor, "The Hamilton Spectator," Hamilton, Ont. (*H*) "Staplehurst," Dundas, Ont. (*A.M. 1918*) (*M. 1929*)

KER, Merle F., B.Sc., (Queen's '18), Township Engr., Township of Stamford, 1810 Ferry St., Niagara Falls, Ont. (*H*) 2057 Drummond Rd. (*Jr. 1920*) (*A.M. 1927*)

KER, Newton James, Asst. Executive Agt., C.P.Ry., Vancouver, B.C. (*H*) 3989 Angus Drive. (*A.M. 1893*) (*M. 1905*)

KERR, Robt. A., B.Eng., (McGill '34), 4765 St. Catherine St. E., Montreal, Que. (*S. 1932*)

KERR, S. Logan, B.S., (Penn. '21), M.E., '24, Sr. Engr., U.S. Engineer Dept., Passamaquoddy Project, Eastport, Maine. (*M. 1935*)

KERRY, Armine John, (R.M.C., Kingston '27), B.Sc., (McGill '29), Capt., R.C.E., Dept. National Defence, St. Louis Barracks, Quebec, Que. (*Jr. 1931*) (*A.M. 1934*)

†KERRY, John G. G., M.Sc., Pres., Kerry & Chace, Ltd., 550 Confederation Life Bldg., Toronto, Ont. (*H*) 12 Algonquin Ave. (*S. 1888*) (*A.M. 1894*) (*M. 1904*)

KERSHAW, Norman Wm., B.Sc., (Sask. '33), Eagle Pencil Co. of Canada Ltd., Drummondville, Que. (*S. 1935*)

♂KERSON, M. Wm., M.S.M., T. Pringle & Son, Ltd., 420 Coristine Bldg., Montreal, Que. (*H*) 2220 Addington Ave. (*A.M. 1931*)

†KESTER, Fred. Henry, Vice-Pres., The Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 162 Windermere Rd. (*A.M. 1918*) (*M. 1926*)

KESTER, Wm. H., 162 Windermere Rd., Walkerville, Ont. (*S. 1934*)

KETCHEN, W. A., B.Sc., (McGill '28), Chief Chemist, Fraser Paper Ltd., Madawaska, Maine. (*H*) Box 718, Edmundston, N.B. (*S. 1924*) (*Jr. 1929*) (*A.M. 1933*)

KETCHEN, Wm. Laird, The British Columbia Pulp and Paper Co. Ltd., Bank of N.S. Bldg., Vancouver, B.C. (*H*) 1935 Haro St. (*M. 1919*)

♂KETTERSON, Andrew Robert, Major, D.S.O., A.R.T.C., (Glasgow), Asst. Engr. of Bridges, C.P.R., Montreal, Que. (*H*) 3652 Northcliffe Ave. (*A.M. 1908*)

♂KEYT, Warren Earnscliffe, Capt., M.C., Asst. Engr., D.P.W., Canada, New Westminster, B.C. (*H*) 221 Royal Ave. (*A.M. 1920*)

♂KIDD, Wm. Sydney, B.A.Sc., (Tor. '20), Production Mgr., E. B. Eddy Co., Hull, Que. (*H*) 89 Aylmer Ave., Ottawa, Ont. (*Jr. 1921*) (*A.M. 1928*)

KILBOURN, Frederick Binns, Gen. Supt. and Dir., Canada Cement Co., Canada Cement Bldg., Montreal, Que. (*H*) 3755 Westmount Blvd., Westmount, Que. (*A.M. 1924*) (*M. 1927*)

KILKENNY, John Murray, O.L.S., 931 Victoria Ave., Niagara Falls, Ont. (*A.M. 1932*)

KILLALY, A. Laurence, Supt'g. Engr., Trent Canal, Dept. Rlys. and Canals, Bank of Commerce Bldg., Peterborough, Ont. (*H*) 502 Weller St. (*S. 1900*) (*A.M. 1910*)

KILLAM, D. A., B.Sc., (McGill '27), Designing Engr., Can. Industries Ltd., Montreal, Que. (*H*) 5797 Plantagenet St. (*S. 1925*) (*Jr. 1928*) (*A.M. 1935*)

KIMPTON, Geoffrey H., B.Eng., (McGill '35), Dom. Rubber Co. Ltd., Montreal, Que. (*H*) 4890 Wilson Ave., N.D.G. (*S. 1934*)

KING, Eric Chas., Churchill River Power Co., Island Falls, Sask., Via Flin Flon, Man. (*Jr. 1935*)

KING, Harry Molyneux, Opr. Supt., Ontario Power Plant, H.E.P.C. of Ontario, P.O. Box 237, Niagara Falls, Ont. (*H*) 434 Philip St. (*M. 1926*)

KING, John David, Mgr., Detroit Stoker Co. of Canada, Rm. 555, New Birks Bldg., Montreal, Que. (*H*) 3436 Durocher St. (*Affil. 1935*)

KING, Peter C., B.Sc., (Queen's '31), 21 Brock Crescent, Toronto, Ont. (*S. 1928*)

KING, Thomas James Fleming, Asst. Dist. Engr., Quebec Dist., C.N.R., Quebec, Que. (*A.M. 1920*)

KINGHORN, Andrew A., B.A.Sc., (Tor. '07), Pres. and Mgr., Kinghorn Construction Co. Ltd., 614 Excelsior Life Bldg., Toronto, Ont. (*H*) 2 Highland Ave. (*M. 1933*)

KINGSMILL, Chas. Grange, B.A.Sc., (Tor. '24), Beauharnois Construction Co., St. Louis de Gonzague, Que. (*Jr. 1927*) (*A.M. 1931*)

†KINGSTON, Charles B., B.A., B.A.Sc., LL.D., Cons. Engr. and Tech. Dir., Globe and Phœnix Gold Mining Co. Ltd., 35 Old Jewry, London E.C.2, England. (*H*) Cherry Croft, Forest Row, Sussex. (*S. 1890*) (*A.M. 1896*) (*M. 1903*)

KINGSTON, Edgar Lloyd, B.Eng., (McGill '34), Box 149, Prescott, Ont. (*S. 1934*)

♂KINGSTON, Laurence B., Capt., M.C., B.Sc., (McGill '08), Engr., Gulf Pulp and Paper Co., Rm. 1010, 65 St. Anne St., Quebec, Que. (*H*) 300 Laurier Ave. (*S. 1905*) (*A.M. 1912*) (*M. 1934*)

KINGSTON, T. M. S., B.A.Sc., (Tor. '24), City Engr., Mgr. and Supt., W.W. Dept., City of Chatham, Ont. (*H*) 560 King St. W. (*S. 1921*) (*Jr. 1927*) (*A.M. 1931*)

KINNEAR, Clifford Rutherford, Asst. Engr. of Way, Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 209 Strathallen Blvd. (*A.M. 1921*)

KIPP, Theodore, Jr., Partner, Sullivan, Kipp Ltd., Cons. Engrs.; Man. Dir., Kipp-Kelly, Ltd., 68 Higgins Ave., Winnipeg, Man. (*H*) 1030 Wellington Crescent. (*M. 1918*)

KIRBY, C. C., Dist. Engr., C.P.R., N.B., Saint John, N.B. (*H*) 119 Hazen St. (*A.M. 1908*) (*M. 1920*)

♂KIRBY, Guy Hurlston, B.Sc., (McGill '22), Elec. Supt., Riverbend Paper Mills, Price Bros. & Co., Ltd., Riverbend, Que. (*S. 1919*) (*A.M. 1923*) (*Member of Council, E.I.C.*)

KIRBY, Thos. Halder, B.Sc., (McGill '13), Vice-Pres., Filer-Smith Machinery Co., Ltd., 703 Confederation Life Bldg., Winnipeg, Man. (*H*) 250 Waverley St. (*A.M. 1919*)

KIRK, W. Douglas, B.Sc., (Queen's '28), E. G. M. Cape & Co., Montreal, Que. (*H*) Apt. 26, 4982 Queen Mary Rd., Montreal, Que. (*S. 1927*)

♂KIRKPATRICK, Alex. M., B.Sc., (Queen's '11), Sr. Asst. Engr., D.P.W. Canada, 3rd Floor, Customs Bldg., Winnipeg, Man. (*H*) 7 Rosemount Apts. (*Jr. 1914*) (*A.M. 1919*)

KIRKPATRICK, Everett Chas., B.Sc., (McGill '06), Mech. Engr., The Steel Co. of Canada, 525 Dominion St., Montreal, Que. (*H*) 47 Ainslie Rd., Montreal West, Que. (*S. 1906*) (*A.M. 1913*) (*M. 1926*)

♂KIRKPATRICK, H. T., B.Sc., (McGill '20), 638 Church St., Toronto, Ont. (*S. 1920*) (*Jr. 1924*) (*A.M. 1931*)

KIRKPATRICK, Paul Chester, B.Sc., (McGill '16), Res. Engr., Fraser Brace Ltd., Montreal, Que. (*H*) 22 Elm St., Cornwall, Ont. (*S. 1915*) (*A.M. 1919*)

KIRSH, Harry, B.Sc., (McGill '25), 4239 Westhill Ave., N.D.G., Montreal, Que. (*Jr. 1926*)

KLEIN, Edward, A.B., E.E., (Columbia '09), Treas., Can. Laco Lamps Co., 1511 St. James St., Montreal, Que. (*H*) 8017 Western Ave., Montreal West, Que. (*A.M. 1920*)

KLEIN, Herman, B.Sc., (McGill '30), 5139 St. Urbain St., Apt. 3, Montreal, Que. (*S. 1929*)

KLOTZ, C. O. P., B.Sc., (Queen's '34), Box 52, Westboro, Ont. (*S. 1933*)

KNAPP, Allen C., B.Sc., (McGill '27), 521 Jefferson Ave., Niagara Falls, N.Y. (*S. 1927*)

♂KNAPP, Edward Winslow, B.Sc., (McGill '23), Elec. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 4385 Melrose Ave. (*Jr. 1923*) (*A.M. 1930*)

♂KNEWSTUBB, Frederick William, B.Sc., (McGill '10), Chief Hydraulic Engr., Water Rights Br., Dept. Lands, Victoria, B.C. (*H*) "Rockmount," Colquitz, B.C. (*A.M. 1915*)

♂KNIGHT, Jas. A., Capt., M.C., B.A.Sc., (Tor. '14), Ont. Sales Engr., Brunner Mond Canada Ltd., 1312 Star Bldg., Toronto, Ont. (*H*) 28 Hepbourne St. (*S. 1914*) (*A.M. 1920*) (*M. 1930*)

KNODELL, J. F., B.Sc., (N.S.T.C. '32), 96 Chebucto Rd., Halifax, N.S. (*S. 1930*)

♂KNOWLES, Percy Morris, Capt., Bldg. Superv., Mtl. Divn. Plant, Bell Telephone Co. of Canada, Beaver Hall Bldg. Montreal, Que. (*A.M. 1929*)

KOEHLER, J. W., B.Sc., (McGill '30), 3860 Harvard Ave., Montreal, Que. (*H*) Swift Current, Sask. (*S. 1929*)

♂KOHL, Geo. H., Major, B.Sc., (McGill '10), Beardmore Leathers, Ltd., 417 St. Peter St., Montreal, Que. (*H*) 4340 Montrose Ave., Westmount, Que. (*Jr. 1913*) (*A.M. 1919*) (*M. 1927*)

KREBSER, E. M., B.Sc., (Vermont '24), Shop Supt., The Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 263 Kildare Rd. (*A.M. 1930*)

KREBSER, Louis E., Isle Cadieux, Que. (*A.M. 1932*)

KUGEL, Emil, C.E., (Vienna), Contracting Engr., 1472 MacKay St., Montreal, Que. (*A.M. 1929*)

♂KUHRING, Paul Ludwig, Asst. Engr., River St. Lawrence Ship Channel, Dept. of Marine and Fisheries, Rm. 532, Hunter Bldg., Ottawa, Ont. (*H*) 35 Lindenlea Rd. (*Jr. 1922*) (*A.M. 1925*)

KURTZ, Harold J., B.Sc., (Queen's '26), Dftsman., Ontario Refining Co., Copper Cliff, Ont. (*H*) 402 Bartram Ave., Sudbury, Ont. (*S. 1925*) (*Jr. 1928*) (*A.M. 1934*)

KWIECIEN, W. J., Address unknown. (*S. 1928*)

KYDD, Geo., B.Sc., (McGill '05), Res. Engr., Hudson Bay Terminals, Dept. of Rlys. and Canals, Churchill. Man. (*H*) 466 MacLaren St., Ottawa, Ont. (*S. 1902*) (*Jr. 1911*) (*A.M. 1914*)

KYLE, John Sheridan, B.Sc., (Alta. '28), Tropical Oil Co., Barranca, Bermeja, Colombia, S.A. (*H*) 82 Cordova St., Winnipeg, Man., Canada. (*S. 1929*) (*Jr. 1930*)

KYLE, Willard Hugh, B.Sc., (McGill '26), Asst. Engr., C.N.R., Montreal, Que. (*H*) 4982 Connaught Ave. (*S. 1926*) (*A.M. 1931*)

LABELLE, Jos., B.A.Sc., (Ecole Polytech., Montreal '03), Engr., Montreal Water Bd., 3161 Joseph St., Montreal, Que. (*H*) 2739 Maplewood Ave. (*S. 1903*) (*A.M. 1909*)

LACKEY, Wesley Jas., B.Sc., (Queen's' 33), 194 Humberside Ave., Toronto. Ont. (*S. 1933*)

LACROIX, Emile, B.A.Sc., (Ecole Polytech., Montreal '10), City Engr. and Mgr., City of Outremont, 543 Cote St. Catherine Road, Outremont, Que. (*H*) 1785 Van Horne Ave. (*A.M. 1921*)

LADNER, Frank E., B.A.Sc., Pioneer Gold Mines, B.C. (*H*) 3926 Kingsway, New Westminster, B.C. (*S. 1931*)

♂LAFERME, Leopold, 5167 Notre Dame de Grace Ave., Montreal, Que (*Jr. 1920*) (*A.M. 1921*)

LAFLECHE, Alphonse, C.E., (Ecole Polytech., Montreal '09), Asst. Chief Engr., River St. Lawrence Ship Channel, Dept. of Marine, Ottawa, Ont. (*H*) 66 Cameron St. (*S. 1909*) (*A.M. 1916*) (*M. 1935*)

LAFONTAINE, D. J., B.Sc., (Queen's '33), Tweed, Ont. (*S. 1931*)

LaFOREST, J. M. M., B.Sc., (Queen's '13), Harbour Commrs. of Montreal, Montreal, Que. (*H*) 1433 Lajoie Ave., Outremont, Que. (*A.M. 1916*)

LAFRAMBOISE, Adhemar, B.A., B.Sc., C.E., Town Engr., Town of LaSalle, Que. (*H*) 35 Stirling Ave., Ville LaSalle, Que. (*S. 1911*) (*A.M. 1916*)

LAFRENIERE, Theo J., B.A.Sc., (Ecole Polytech., Montreal '09), M.Sc., (M.I.T. '12), D.Sc., Chief Engr., Bureau of Health, Prov. of Quebec, 89 Notre Dame St. East, Montreal, Que. (*H*) 418 Pine Ave. W. (*M. 1920*)

LAIDLAW, Douglas S., B.A.Sc., (Tor. '28), Strl. Engr., Catto & Catto & Laidlaw, Ste. 310, 68 King St. E., Toronto, Ont. (*H*) 35 Highview Cres. (*Jr. 1930*) (*A.M. 1935*)

LAING, Addison K., B.Sc., (McGill '30), Jr. Hydrographer, Marine Dept., Hunter Bldg., Ottawa, Ont. (*H*) 219 Fourth Ave. (*S. 1926*) (*A.M. 1934*)

♂LAKIN, John Thos., Lieut., M.C., Plant Engr., Wabasso Cotton Co. Ltd., Three Rivers, Que. (*H*) 1237 St. Louis Blvd. (*A.M. 1932*)

LALAND, Arne, Grad. (Trond.), Address unknown. (*Jr. 1930*)

L'ALLIER, Lucien, B.Eng., (McGill '35), Bell Telephone Co. of Canada, Montreal, Que. (*H*) 5022 de La Roche. (*S. 1934*)

LALONDE, J. Antonio, B.A.Sc., (Ecole Polytech. Montreal '12), Chief Engr., A. Janin & Co. Ltd., and Mgr., A. Janin Paving Co. Ltd., 1460 Sherbrooke St. W., Montreal, Que. (*H*) 958 Dunlop Ave., Outremont, Que. (*S. 1910*) (*Jr. 1915*) (*A.M. 1920*)

LALONDE, Jean Paul, B.Sc., (Ecole Polytech., Montreal '26), Chief Engr., J. M. Eugene Guay, Inc., 617 Keefer Bldg., Montreal, Que. (*H*) 2042 Marlowe Ave. (*S. 1925*) (*A.M. 1935*)

♂LAMB, Henry John, Lt.-Col., D.S.O., (R.M.C., Kingston), Dist. Superv. Engr., Prov. of Ont., D.P.W., Canada, 24 Adelaide St. E., Toronto, Ont. (*A.M. 1899*) (*M. 1905*)

LAMBART, Howard F. J., B.Sc., (McGill '04), D.L.S., Surveyor, Topographical Surveys, Dept. Inter., Ottawa, Ont. (*H*) 315 Stewart St. (*S. 1902*) (*A.M. 1907*)

LAMBERT, John Bain, Asst. Engr., D.P.W., Canada, P.O. Bldg., New Westminster, B.C. (*H*) 1545-14th Ave W. (*A.M. 1920*)

LAMBERT, Walter, Lambert & German, Naval Archts., 1019 Canada Cement Bldg., Montreal, Que. (*M. 1921*)

LAMBERT, Zephirin, (Ecole Polytech., Montreal '13), City Engr., Three Rivers, Que. (*H*) 534 Blvd. Laviolette. (*M. 1932*)

♂LAMOTHE, George Edmond, Capt., M.C., B.A.Sc., (Ecole Polytech., Montreal '13), Engr., Logging Dept., Price Bros. & Co. Ltd., Chicoutimi, Que. (*S. 1910*) (*Jr. 1916*) (*A.M. 1920*)

LAMOUREUX, Joseph A., B.Sc., (Ecole Polytech., Montreal '98), Engr., D.P.W., Canada, Ottawa, Ont. (*H*) 50-4th Ave. (*A.M. 1909*)

LAMOUREUX, Marcel, B.Eng., (McGill '32), 3700 St. Hubert St., Montreal, Que. (*Jr. 1934*)

LANCTOT, Guy, B.A.Sc., (Ecole Polytech., Montreal '32), Proctor & Gamble Co. Ltd., 1600 Delorimier Ave., Montreal, Que. (*S. 1930*)

LANCTOT, Raymond, B.Sc., (McGill '24), Technical Asst., Aluminum Co. of Canada Ltd., P.O. Box 87, Arvida, Que. (*S. 1922*) (*Jr. 1926*)

LANDRY, Jos. H., B.A., B.Sc., (Laval '13), Sr. Asst. Engr., D.P.W., P.O. Box 129, Station H, Montreal, Que. (*H*) 4056 Marcil Ave. (*A.M. 1919*)

LANG, Eugene C., B.Sc., (Armour), Asst. to Executive Vice-Pres., Utilities Power and Light Corpn., 327 So. La Salle St., Chicago, Ill. (*H*) Geneva Rd., St. Charles, Ill. (*M. 1931*)

♂LANG, John Leiper, B.A.Sc., Major,(Tor. '07), D.L.S., O.L.S., Partner, Lang & Ross, Ltd., Sault Ste. Marie, Ont. (*H*) 1085 Queen St. (*M. 1921*)

LANG, J. T., B.Sc., (N.S.T.C. '31), Canadian Johns-Manville Co., Asbestos, Que. (*S. 1930*) (*Jr. 1931*)

LANGFORD, J. A., B.Sc., (Tor. '22), Elec. Engr., Can. and General Finance Co., 25 King St. W., Toronto, Ont. (*H*) 141 Brookdale Ave. (*A.M. 1929*)

LANGLAIS, Zachee, B.Sc., (Ecole Polytech., Montreal), Cons. Engr., 105 Mountain Hill, P.O. Box 27, Upper Town, Quebec, Que. (*H*) 37 Ave. des Braves (*S. 1911*) (*A.M. 1915*)

LANGLOIS, Amedee, B.A.Sc., (Ecole Polytech., Montreal), Patent Examiner, P.O. Box 183, Ottawa, Ont. (*S. 1909*) (*A.M. 1913*)

LANGLOIS, Raoul, B.A.Sc., (Ecole Polytech., Montreal '12), Asst. Chief Engr., Montreal Tramways Comm., 159 Craig St. W., Montreal, Que. (*A.M. 1928*)

LANGLOIS, W. L., B.A.Sc., (Tor. '23), Div. Engr., Dept. of Northern Development, Barry's Bay, Ont. (*H*) 167 College St., Sudbury, Ont. (*S. 1923*) (*Jr. 1925*) (*A.M. 1935*)

♂LANGSTROTH, Cecil Craven, Lieut., B.Sc., (McGill '21), Asst. Mgr., Dom. Hoist and Shovel Co. Ltd., Box 3150, Montreal, Que. (*H*) 4859 Wilson Ave (*S. 1921*) (*A.M. 1927*)

♂La PLANT, Jno. F., Simcoe, Ont. (*A.M. 1932*)

LAPLANTE, J. H. A., B.Sc., (Ecole Polytech., Montreal '33), Engr., Dept. de la Voirie, Parliament Bldg., Quebec, Que. (*H*) Ancienne Lorette, Que. (*S. 1934*)

LAPLANTE, René, B.A., B.A.Sc., (Ecole Polytech., Montreal '29), Asst. Engr., Shawinigan Water and Power Co., P.O. Box 2670, Montreal, Que. (*H*) Valleyfield, Que. (*A.M. 1935*)

LARIVIERE, Alex., B.A.Sc., (Ecole Polytech., Montreal '13), Commr., Quebec Public Service Comm., Court House, Quebec, Que. (*H*) 174 Aberdeen St. (*S. 1910*) (*Jr. 1914*) (*A.M. 1917*) (*M. 1932*)

LARNER, C. W., Pres., The Larner Engineering Co., Lincoln-Liberty Bldg., Philadelphia, Pa. (*M. 1913*)

LAROCHELLE, Joseph E., Hunter Bldg., O'Connor St., Ottawa, Ont. (*A.M. 1903*)

LARRIVEE, J. A. E., B.Sc., (N.B. '27), Dist. Engr., Agriculture Dept., Quebec. Address: Victoriaville, Arthabaska Co., Que. (*Jr. 1930*)

LATHAM, Richard L., B.A.Sc., (Tor. '01), Chief Engr., T.H. & B. Rly., Vice-Pres., Toronto, Hamilton and Buffalo Navigation Co., Hamilton, Ont. (*H*) 146 Aberdeen Ave. (*A.M. 1906*) (*M. 1913*)

LATIMER, Frank Herbert, (R.M.C., Kingston '82), D.L.S., B.C.L.S., Private Practice, 102 Eckhardt Ave. W., Penticton, B.C. (*M. 1917*)

LATTA, W. S. B., Alberni Pacific Lumber Co. Ltd., Port Alberni, B.C. (*H*) 2653 Dalhousie St., Victoria, B.C. (*S. 1930*)

LAUCHLAND, L. S., B.A.Sc., (Tor. '34), Box 330, Dundas, Ont. (*S. 1929*)

LAURENCE, Emile, B.A.Sc., (Ecole Polytech., Montreal '26), Bridge Engr., D.P.W., Quebec, Parliament Bldg., Quebec, Que. (*H*) 118 Brown St. (*Jr. 1930*) (*A.M. 1934*)

LAURENCE, Harold F., Inspn. Engr., Dept. of Highways, Prov. N.S., Halifax, N.S. (*A.M. 1906*) (*M. 1910*)

LAURIE, Albert, B.A.Sc., (McGill '98), Laurie & Lamb, 300 St. Sacrament St., Montreal, Que. (*H*) 653 Victoria Ave., Westmount, Que. (*M. 1921*)

LAURIE, E. Stuart, B.Eng., (McGill '33), 653 Victoria Ave., Westmount, Que. (*S. 1933*)

LAURIE, Wm. Little, B.A.Sc., (Tor. '24), Major, Chief Technical Officer, R.C.S., Dept. of National Defence, Elgin Bldg., Ottawa, Ont. (*H*) 215 Metcalfe St. (*Jr. 1924*) (*A.M. 1931*)

LAVOIE, Edouard, B.A., (Laval), B.Sc., (Queen's '07), Lavoie & Delisle, Box 178, Chicoutimi, Que. (*M. 1923*)

LAWRASON, W. M., 296 St. George St., Toronto, Ont. (*S. 1931*)

♂LAWRENCE, Alfred John, Major, B.Sc., (McGill '14), Northern Electric Co., Montreal, Que. (*H*) 662 Davaar Ave. (*S. 1915*) (*Jr. 1916*) (*A.M 1917*)

LAWRENCE, Edward Arthur, Irrigation Br., Dept. Nat. Res., C.P.R., 207-7th St. S., Lethbridge, Alta. (*S. 1932*) (*Sec.-Treas., Lethbridge Br., E.I.C.*)

♂LAWRENCE, Robt. Spencer, Lieut., Watermaster, Irrigation Br., C.P.R., A.R. & I. Bldg., Lethbridge, Alta. (*H*) Box 151, Coaldale, Alta. (*A.M. 1920*)

LAWRENCE, S. N., B.A.Sc., (Tor. '30), Can. Gen. Elec. Co. Ltd., 1024 Lansdowne Ave., Toronto, Ont. (*H*) Sheridan, Ont. (*S. 1930*)

♂LAWRENCE, W. S., Lt.-Col., (R.M.C., Kingston '09), R.C.E., Dept. of National Defence, Engineer Yard, Halifax, N.S. (*H*) Bellevue Annex, Spring Garden Rd. (*Jr. 1914*) (*A.M. 1925*)

LAWSON, Horace H., Major, (R.M.C., Kingston '10), O.L.S., Assoc. Prof. of Surveying, R.M.C., Kingston, Ont. (*H*) 25 Wellington St. (*A.M. 1932*)

♂LAWSON, Wilfrid S., Major, Chief Engr., Penitentiaries Br., Dept. of Justice, Confederation Bldg., Ottawa, Ont. (*H*) 104 The Driveway. (*A.M. 1907*) (*M. 1916*)

LAWTON, Fred Lewis, B.A.Sc., (Tor. '23), Elec. Engr., Duke-Price Power Co. Ltd., Arvida, Que. (*S. 1920*) (*A.M. 1928*)

♂LAYNE, Geoffrey Francis, Lieut., M.C., B.Sc., (McGill '14), Mech. Supt., Price Bros. & Co. Ltd., Box No. 7, Riverbend, Que. (*S. 1914*) (*Jr. 1919*) (*A.M. 1920*)

♂LAYNE, John Graham, Sub-Lt., R.N.V.R., B.Sc., (McGill '23), Mgr., West India Rum Refinery Ltd., St. Michael 26, Barbados, B.W.I. (*S. 1921*) (*A.M. 1928*)

LAZENBY, Frederic Arthur, Port Hammond, B.C. (*S. 1923*)

LAZENBY, Thos. Wm., Kingston Penitentiary, Dept. of Justice, Box 22, Kingston, Ont. (*H*) 31 Livingston Ave. (*Jr. 1928*) (*A.M. 1934*)

LAZIER, Francis S., B.Sc., (Queen's '07), 75 Victoria Ave., Belleville, Ont. (*S. 1906*) (*A.M. 1911*) (*M. 1920*)

LAZORKA, D., B.E., Box 165, Borden, Sask. (*S. 1931*)

LEA, Harry Windsor, B.Sc., (McGill '31), Designing Engr., Montreal Sewers Comm., City Hall, Montreal, Que. (*H*) Apt. 7, 1117 St. Matthew St. (*Jr. 1924*) (*A.M. 1935*)

†LEA, Richard S., B.Sc., Ma.E., (McGill '90), Cons. Engr., 1226 University St., Montreal, Que. (*S. 1887*) (*A.M. 1894*) (*M. 1900*)

LEA, Wm. Chester, B.Eng., (McGill '32), Engr., Sales Constrn. and Mtce. Dept., Sun Oil Co. Ltd., Ft. of Bouchette St., Toronto, Ont. (*S. 1931*)

LEA, William S., B.Sc., (McGill), Cons. Engr., 1226 University St., Montreal, Que. (*H*) 1 Richelieu Place (*A.M. 1909*) (*M. 1913*)

♂LEADLAY, Francis Robt., B.Sc., (Queen's '25), Engrg. Dept., Toronto, Hamilton & Buffalo Railway Co., Hamilton, Ont. (*H*) 90 Oak Knoll Dr., Westdale, Hamilton, Ont. (*S. 1925*) (*A.M. 1929*)

LEAHEY, Jas. C. P., B.Eng., (McGill '35), c/o C. A. P. Leahey, Bank of Montreal, Bank St. Br., Ottawa, Ont. (*S. 1935*)

LEAVENS, J. W., B.Sc., (Queen's '30), Bloomfield, Ont. (*S. 1928*)

LEAVER, Charles Burfoot, B.A.Sc., (Tor. '10), Gen. Mgr., Imperial Oil, Ltd., 56 Church St., Toronto, Ont. (*H*) 273 Mossom Rd. (*A.M. 1918*)

LeBARON, K. S., B.Sc., (McGill '23), Plant Engr., Can. International Paper Co., Three Rivers, Que. (*H*) 102 St. Maurice St. (*S. 1920*) (*A.M. 1926*)

LeBEL, Gerard, 3716 Adam St., Montreal, Que. (*S. 1935*)

LeBLANC, C. Jos., B.A.Sc., (Ecole Polytech., Montreal '10), Q.L.S., Asst. Supt. of Roads, City of Montreal. (*H*) 169 Jarry St., Villeray Ward, Montreal, Que. (*A.M. 1920*)

LeBLANC, Jules, B.A.Sc., (Ecole Polytech., Montreal '28), Q.L.S., 739 Dunlop Ave., Outremont, Que. (*S. 1928*) (*Jr. 1932*)

LeBOURVEAU, Homer Benjamin, B.A., B.Sc., (Alta. '24), Asst. Engr., Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 1418-4-A St. N.W. (*A.M. 1930*)

LeBOUTILLIER, W. P. C., B.Sc., (McGill '27), Asst. Constrn. Records Engr., Price Bros. & Co. Ltd., Kenogami, Que. (*Jr. 1929*)

♂LeCAPELAIN, Chas. King, Engr., National Parks of Canada, Box 232, Banff, Alta. (*A.M. 1933*)

LECKY, Robert John, Mgr., R. J. Lecky & Associates; Secy., Building and Construction Industries Exchange, 342 W. Pender St., Vancouver, B.C (*H*) 6450 Elm St. (*A.M. 1907*)

LECKY, Wm. John, B.Eng., (McGill '32), Sales Engr., Holman Machines Ltd., Montreal, Que. Address: P.O. Box 164, Noranda, Que. (*S. 1932*)

♂LeCLAIR, Wm. Jas., Capt., Chief of Lumber Seasoning Divn., Forest Products Laboratories of Canada, Dept. Inter., Ottawa, Ont. (*H*) 66 Driveway. (*S. 1914*) (*Jr. 1919*) (*A.M. 1928*)

LECLAIRE, Jos. Paul, B.A.Sc., (Ecole Polytech., Montreal '02), Chief Engr., Harbour Commrs. of Montreal. (*H*) 191 Maplewood Ave., Outremont, Que. (*M. 1925*)

LEE, Frank, (Yale '94), Divn. Engr., C.P.Ry., Vancouver, B.C. (*M. 1908*)

LEE, Fred S., B.A.Sc., (Tor. '32), 336 Runnymede Rd., Toronto, Ont. (*S. 1932*)

♂LEE, L. A. C., B.A.Sc., (Tor. '16), Chief Concrete Engr., Bldg. Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 209 Silverbirch Ave. (*M. 1934*)

LEE, Wm. States, Jr., C.E., (Princeton '24), Pres., W. S. Lee Engineering Corpn., Power Bldg., Charlotte, N.C. (*H*) 2601 Sherwood Ave. (*A.M. 1930*)

LEES, Thomas, A.R.T.C., (Glasgow), Dist. Engr., C.P.R., Calgary, Alta (*H*) 2106–7th St. W. (*A.M. 1911*) (*M. 1928*)

LEFEBVRE, Jean, B.A.Sc., (Ecole Polytech., Montreal '34), Chem. Engr., Imperial Oil Ltd., Montreal East, Que. (*H*) 35 Joyce Ave., Outremont, Que. (*S. 1934*)

LEFEBVRE, Joseph Alexis, Principal Engr., Dist. No. 2, Highways Dept., Parliament Bldgs., Quebec, Que. (*H*) 47 Vallee Blvd., Beauport, Que. (*A.M. 1915*) (*M. 1926*)

†LEFEBVRE, Olivier Odilon, B.A.Sc., (Ecole Polytech., Montreal '02), D.Sc., Chief Engr., Quebec Streams Commission, Rm. 222, New Court House, Montreal, Que. (*H*) 26 Robert Ave., Outremont, Que. (*S. 1903*) (*A.M 1912*) (*M. 1920*) (*Past-President*)

LEFORT, Jean, 5577 Philips Ave., Montreal, Que. (*S. 1935*)

♂LEGER, Oswald E., Capt., Asst. to Pres., Hamilton Bridge Co., Hamilton, Ont. (*A.M. 1924*)

LEGG, H. Gale, Sr. Asst. Engr., D.P.W., 952 Hunter Bldg., Ottawa, Ont. (*A.M. 1926*)

LEGG, John H., B.Sc., (McGill '29), Mill Supt., Aldermac Mines, Ltd., 1010 St. Catherine St. W., Montreal, Que. Address: 712 Jefferson Apts., Niagara Falls, N.Y. (*S. 1927*) (*A.M. 1935*)

LEGGET, Robt. F., B.Eng., (Liverpool '25), (M.Eng., '27), Can. Sheet Piling Co. Ltd., 1106 Castle Bldg., Montreal, Que. (*H*) 98–54th Ave., Lachine, Que. (*Jr. 1929*) (*A.M. 1931*)

LEGRIS, Charles E., B.Sc., (McGill '14), Constrn. Engr., U.S. Treas. Dept., P.W. Br., Worthington, Minn. (*H*) 52 Vassar Ave., Providence, R.I. (*A.M. 1923*)

LEIGHTNER, D. B., B.Sc., (Man. '31), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) Jansen, Sask. (*S. 1929*)

LEIGHTON, Chester Adam, Gen. Supt., The Arthur A. Johnson Corp., Chatham Phœnix Bldg., Long Island City, N.Y. (*H*) 9 College Ave., Amherst, Mass. (*A.M. 1924*)

LEITCH, Hugh Jas., B.Sc., (McGill '26), Mgr., Warehouse Dept., Dom. Bridge Co. Ltd., P.O. Box 4016, Montreal, Que. (*H*) 5041 Glencairn Rd. (*S. 1920*) (*Jr. 1927*) (*A.M. 1934*)

LEMAN, Beaudry, B.Sc. Dr.C.Sc., Pres., Banque Canadienne Nationale, Montreal, Que. (*H*) 597 St. Catherine Rd., Outremont, Que. (*S. 1901*) (*A.M. 1902*)

LEMBCKE, Robert E., B.S. in C.E., Asst. Engr., T. & P. Rly., Rm. 213, T. & P. Depot, Fort Worth, Texas, U.S.A. (*H*) 2014 Market St. (*A.M. 1914*)

LEMIEUX, Gilbert, B.A., 195 St. Jean St., Quebec, Que. (*S. 1935*)

LEMON, Marvin R., B.A.Sc., (Tor. '33), Stouffville, Ont. (*S. 1933*)

♂LEONARD, Ibbotson, Col., D.S.O., (R.M.C., Kingston '03), B.Sc., (McGill '05), Pres., E. Leonard & Sons, Ltd., 381 York St., London, Ont. (*H*) 782 Wellington St. (*S. 1903*) (*A.M. 1912*) (*M. 1922*)

♂LePAN, Arthur D'Orr, Lt.-Col., B.A.Sc., (Tor. '08), Supt., University of Toronto, Toronto, Ont. (*H*) 82 Walmer Rd. (*A.M. 1921*)

LEROUX, Albert, C.E., (Ecole Polytech., Montreal), Asst. Engr., Montreal Water Board, 259 Joseph St., Verdun, Que. (*H*) 3535 Lacombe Ave., Montreal, Que. (*A.M. 1921*)

LEROUX, Louis Jos., B.A.Sc., (Ecole Polytech., Montreal '06), Engr. of Bridges and Tunnels, City of Montreal, Rm. 407, City Hall, Montreal, Que. (*H*) 28 Holyrood Ave., Outremont, Que. (*A.M. 1930*)

LeROY, Wm. Lindsay, Constrn. Supt., R. Beggs & Sons, Hallville, Ont. (*H*) Prescott, Ont. (*M. 1926*)

LESLIE, James, Waterworks and Fire Appliance Engr., Can. Fire Underwriters Assoc., 524 Coristine Bldg., Montreal, Que. (*H*) Apt. 7, 3141 Maplewood Ave. (*Affil. 1924*)

LESLIE, Roy Campbell, M.Sc., (Tor. '24), Asst. Engr., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 676 Victoria Rd. (*S. 1921*) (*Jr. 1925*) (*A.M. 1930*)

LESSARD, C. Camille, B.S.A. and C.E., (Ecole Polytech., Montreal '22), Cons. Engr., 32 Blvd. des Alliés, Quebec, Que. (*A.M. 1922*)

♂LESTER, Jas. Fred., Lieut., Res. Engr., Dept. Northern Development, Parliament Bldgs., Toronto, Ont. (*H*) P.O. Box 1056, Kenora, Ont. (*A.M. 1920*)

LETCH, Harry George, B.Eng., (McGill '32), National Breweries Ltd., 740 St. Maurice St., Montreal, Que. (*H*) 66 Oak Ave., St. Lambert, Que. (*S. 1929*)

LEVIN, Max., B.Sc., (Man. '30), M.A.Sc., (Tor. '33), Ste. 19, N. Panama Apts., Winnipeg, Man. (*S. 1928*)

LEVINTON, Zusse, B.Sc., M.Sc., (Sask. '34), Ridgedale, Sask. (*S. 1934*)

LEWIS, David J., B.Sc., (Queen's '24), Dominion Bridge Co. Ltd., Lachine, Que. (*H*) 169–44th Ave. E., Lachine, Que. (*S. 1922*) (*A.M. 1929*)

LEWIS, David O., Cons. Civil Engr., 816 Vancouver Blk., Vancouver, B.C. (*H*) 1055–12th Ave. W. (*A.M. 1894*) (*M. 1907*)

LEWIS, E. Keith, B.Sc., (N.S.T.C. '30), Imperial Oil Ltd., Dartmouth, N.S. (*H*) 32 Tulip St. (*S. 1929*) (*Jr. 1935*)

♂LEWIS, Hugh Miles, Lieut., M.S.M., Plant Engr., Pacific Mills Ltd., Box 337, Ocean Falls, B.C. (*A.M. 1920*)

♂LIBBY, Philip Nason, B.Sc., (Maine '17), Mech. Engr., Tennessee Eastman Corp., Kingsport, Tenn. (*H*) 339 Center St. (*Jr. 1922*) (*A.M. 1927*)

LICHTY, Lyall J., B.A.Sc., (Tor. '33), Arntfield Gold Mines Ltd., Arntfield, Que. (*S. 1931*)

♂LIGERTWOOD, H. C. G., B.Sc., (Man. '24), Ste. 7, Plaza Apts., Winnipeg, Man. (*A.M. 1934*)

LILLEY, L. G., B.Sc., (N.B. '35), 57 Havelock St., WestSaintJohn, N.B. (*S. 1935*)

♂LINDSAY, Chas. C. (*q*), Major, M.C., C. de G., B.Sc., (McGill '15), Partner, M. D. Barclay, Inc., and Lindsay & Belanger, Rms. 806-8, Tramways Bldg., Montreal, Que. (*H*) 60 Willowdale Ave. (*S. 1908*) (*A.M. 1919*)

♂LINDSAY, Guy Adamson, Lieut., B.Sc., (McGill '20), Sr. Office Engr., St. Lawrence Waterway Project, Dept. of Rlys. and Canals, Ottawa, Ont. (*H*) 69 Ossington Ave. (*S. 1914*) (*A.M. 1922*)

LINDSEY, Chas R., B.Sc., (Ohio Nor. '05), Power Engineering Co. Ltd., Power Bldg., Montreal, Que. (*H*) 534 Clarke Ave., Westmount, Que. (*A.M. 1916*)

LINGLEY, Harold P., B.Sc., (N.B. '30), Jr. Engr., D.P.W., Canada, P.O. Box 643, Saint John, N.B. (*S. 1930*)

LINK, Norman Archibald, Roadmaster, C.P.R., Nipawin, Sask. (*A.M. 1927*)

♂LINTON, Adam P., Lt.-Col., O.B.E., B.A.Sc., (Tor. '08), Chief Bridge Engr., Dept. of Highways, Sask., Regina, Sask. (*H*) 3080 Rae St. (*S. 1908*) (*A.M. 1913*) (*M. 1935*)

LIPPE, Louis E. H., Q.L.S, City Engr., Joliette, Que. (*S. 1905*) (*A.M. 1912*)

♂LITTLE, Edward Caruthers, Lieut., (Belgian C. de G.), B.Sc., (McGill '15), Supt., So. Divn., Dept. of Rlys. and Canals, Welland Ship Canal, Port Colborne, Ont. (*H*) 171 Division St., Welland, Ont. (*S. 1913*) (*Jr. 1919*) (*A.M. 1921*)

LITTLE, Harold R., B.Sc., (McGill '11), Partner, Lawson & Little, 1227 University Tower, Montreal, Que. (*H*) 11 Anwoth Rd., Westmount, Que (*S. 1909*) (*A.M. 1913*)

LITTLE, Harry, Sales Engr., R. and M. Bearings Canada, Ltd., 1006 Mountain St., Montreal, Que. (*H*) 14 Perrault Ave., Ste Anne de Bellevue, Que. (*S. 1931*)

♂LIVINGSTON, David A., Major, c/o C.P.R., Reston, Man. (*S 1909*) (*A M 1909*)

LIVINGSTONE, Robert, Mgr., Lethbridge Collieries, Ltd., Lethbridge, Alta. (*H*) 518–14th St. S. (*M. 1923*)

LLEWELLYN, Leopold Wm., B.Sc., (Sask. '27), Northwestern Iron Wks. Ltd., Regina, Sask. (*H*) 2169 McIntyre St. (*Jr. 1929*)

LLOYD, David S., B.A.Sc., (Tor. '25), Service Engr., Dom. Oxygen Co., Ltd., Rm. 712, 159 Bay St., Toronto 2, Ont. (*H*) 82 Woodlawn Ave E (*S. 1923*) (*Jr. 1928*) (*A.M. 1933*)

LLOYD, M. F. R., Canal Supt., Dept. of Nat. Res., C.P.R., Box 84, Magrath, Alta. (*A.M. 1922*)

LOCHHEAD, John S., 345 Ballantyne Ave., Montreal West, Que (*S. 1934*)

LOCHHEAD, K. Y., B.Eng., (McGill '32), Asst. to Supt., Bldgs. Dept., Hudson's Bay Co., 79 Main St., Winnipeg, Man. (*S. 1931*)

LOCHHEAD, Stuart G., Jr. Engr., City of Westmount, Que. (*H*) 66 Strathearn Ave., Montreal West, Que. (*S. 1928*) (*Jr. 1931*)

LOCKE, C. W. E., 1967 Barclay St., Vancouver, B.C. (*S. 1930*)

LOCKWOOD, Clarence Kingsley, B.Eng., (McGill '35), 602 Cote St. Antoine Rd., Westmount, Que. (*S. 1935*)

♂LOGAN, Robert Archibald, Major, D.L.S., N.S.L.S., Executive Dept., Pan-American Airways Inc., Chrysler Bldg., New York, N.Y. (*H*) Ste. 5900, 135 E. 42nd St. (*A.M. 1924*)

LOGAN, R. S., Jr., B.Sc., (McGill '25), 45 Aberdeen Ave., Westmount, Que. (*S 1922*) (*A.M. 1933*)

LOGAN, William A., 14 Murray St., Peterborough, Ont. (*A.M. 1903*) (*Life Member*)

LOGIE, Ernest Roy, Divn. Engr., C.N.R., Belleville, Ont. (*H*) 15 Queen St (*A.M. 1921*)

LOMBARD, Robert A., B.Sc., (N.S.T.C. '32), R.R. 1, Malagash, N.S. (*S. 1932*)

LONDON, Woodrow P., B.Sc., (N.B. '34), 174 Waterloo St., Saint John, N.B. (*S. 1934*)

LONG, Geo. Freeman, B.Sc., (Man. '24), 2428 N. Hamlin Ave., Chicago, Ill. (*S. 1922*) (*Jr. 1929*)

♂†LONGLEY, Francis Fielding, Col., C.B.E., D.S.M., (West Point '02), Vice-Pres., Lock Joint Pipe Co., Ampere, N.J. (*H*) 11 Courter Ave., Maplewood, N.J. (*A.M. 1911*) (*M. 1920*)

LONGSTAFF, John Calvin, (Tor. '10), c/o R.C.E., St. Louis Barracks, Quebec, Que. (*A.M. 1931*)

♂LORD, Ernest Ellis, Lieut., Estimator, Smith Bros. & Wilson, Ltd., 104 Donahue Bldg., Regina, Sask. (*H*) 3027 McCallum Ave. (*A.M. 1923*)

LORD, Geo. Ross, B.A.Sc., (Tor. '29), S.M., Lecturer, Mech. Engrg., University of Toronto, Toronto, Ont. (*H*) 5 Cottingham Rd. (*S. 1927*) (*A.M. 1934*)

♂LOTT, Harry C., Lieut.-Col., M.C., Balfour Beatty & Co., Ltd., 66 Queen St., E.C.4, London, England. Res.: Constitutional Club, Northumberland Ave., London, W.C.2. (*S. 1907*) (*A.M. 1913*)

♂LOUDON, Thomas R., Major, B.A.Sc., (Tor. '06), Prof. of Applied Mechanics, University of Toronto, Toronto, Ont.; Cons. Engr. (*H*) 189 Sheldrake Blvd (*A.M. 1910*) (*M. 1919*)

♂LOVE, Alexander, Lieut., B.Sc., (Glasgow '12), Plant Engr., Hamilton Bridge Co., Hamilton, Ont. (*H*) 40 Paisley Ave. S. (*A.M. 1920*) (*M. 1934*) (*Sec.-Treas., Hamilton Br., E.I.C.*)

LOVE, Edwin Reginald, B.Sc., (Man. '34), 184 Good St., Winnipeg, Man. (*S. 1931*)

†LOVELACE, Edgar S. M., B.A.Sc., (McGill '88), 457 Elm Ave., Westmount, Que. (*S. 1887*) (*A.M. 1893*) (*M. 1906*) (*Life Member*)

♂LOVELL, William Edward, B.Sc., (Man. '21), Prof. of Elec. Engrg., University of Saskatchewan, Saskatoon, Sask. (*H*) 1224 Elliott. (*S. 1911*) (*A.M. 1925*)

LOVETT, Percy Arthur, B.Sc., (N.S.T.C. '28), Sec.-Treas., Engineering Service Co. Ltd., Halifax, N.S. (*H*) 107 Morris St. (*S. 1928*) (*Jr. 1931*) (*A.M. 1935*)

LOW, Charles D., 376 Lewis St., Ottawa, Ont. (*S. 1929*)

♂LOW, Charles M., Lieut., B.Sc., (Edinburgh '11), Supt., Root River Portages, Root River Portage, Via Hudson, Ont. (*A.M. 1921*)

LOW, Richard Alex., B.Sc., (Queen's '28), Lecturer and Instructor in Surveying, Queen's University, Kingston, Ont. (*H*) 174 Barrie St. (*A.M. 1929*)

LOWRIE, Andrew W. P., B.A.Sc., (Tor. '11), 510–11th St. W., Calgary, Alta., (*A.M. 1916*)

♂LOY, J. Austin, Capt., M.C., B.Sc., (McGill '21), Div. Plant Engr., The Bell Telephone Co. of Canada, Ottawa, Ont. (*H*) 243–4th Ave. (*S. 1919*) (*Jr. 1922*) (*A.M. 1927*)

LUCAS, John Wm., B.Sc., (Alta. '30), Testing Labs., D.P.W., West Block, Ottawa, Ont. (*S. 1928*) (*Jr. 1932*)

♂LUCAS, Leslie, Capt., M.C., Northern Electric Co. Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 5039 Glencairn Ave. (*Jr. 1925*) (*A.M. 1928*)

♂LUCK, Cecil George John, Capt., M.C. and Bar, Divn. Engr., Dept. of Northern Development, Toronto, Ont. (*H*) 708 Spadina Ave (*A.M. 1920*)

LUMBERS, Wm. Cooper, (Tor. '01), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 67 Metcalfe St. (*A.M. 1921*)

♂LUMSDEN, Hugh Allan, Major, B.Sc., (McGill '12), County Engr., County of Wentworth, Court House, Hamilton, Ont. (*H*) 250 Duke St. (*S. 1905*) (*Jr. 1911*) (*A.M. 1913*) (*M. 1923*)

LUNN, Fred Richard, B.Sc., (McGill '29), 458 Argyle Ave., Westmount, Que. (*S. 1927*)

LUPTON, Mac Joseph, B.Sc., (Man. '34), Y.M.C.A., 1441 Drummond St., Montreal, Que. (*S. 1934*)

LUSBY, G. W., B.Sc., (N.S.T.C. '25), Ford Motor Co. of Canada, East Windsor, Ont. (*H*) 247 Gladstone Ave., Windsor, Ont. (*S. 1925*) (*Jr. 1931*)

LUSCOMBE, Charles, Supt. of Constrn., The Shawinigan Engineering Co., Power Bldg., Montreal, Que. Address: P.O. Box 264, La Tuque, Que. (*A.M. 1908*)

LYMAN, Chas. Philip, B.Eng., (McGill '33), 4155 Cote des Neiges Rd., Montreal, Que. (*Jr. 1935*)

LYNCH, F. C. C., Director, Bureau of Economic Geology, Geological Survey, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont. (*H*) 283 Wilbrod St. (*Affil. 1916*) (*A.M. 1924*) (*Sec.-Treas., Ottawa Br., E.I.C.*)

LYNCH, John Franklin, B.Sc., (N.B.), (El. '29, Ci. '33), 201 Northumberland St., Fredericton, N.B. (*Jr. 1932*)

LYNDE, C. J., Jr., B.Sc., (McGill '29), Northern Electric Co., Ltd., 1261 Shearer St., Montreal, Que. (*S. 1924*)

♂LYNN, Harold Riviere, Major, Pres., Lynn, MacLeod Engineering Supplies Ltd., Box 278, Thetford Mines, Que. (*A.M. 1920*)

LYON, G. M., B.Sc., (Man. '31), 1278 Wellington Cres., Winnipeg, Man. (*S. 1929*)

♂LYON, John Edward, Major, R.C.E., (R.M.C., Kingston '17), D.L.S., O.L.S., D.E.O., M.D. No 3, Dept. National Défence, Kingston, Ont. (*H*) 5 Wellington St. (*Jr. 1919*) (*A.M. 1929*)

LYONS, Gerald Stanley, B.Sc., (Queen's '24), Toll Cable Engr., The Bell Telephone Co. of Canada, Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4552 Draper Ave. (*S. 1922*) (*Jr. 1930*)

LYS, Chas. Robt., Dist. Engr., Reclam. Br., Prov. Govt., Rm. 316, Parliament Bldgs., Winnipeg, Man. (*H*) 246 Conway St. (*A.M. 1920*)

♂LYSTER, Horace M., Lieut., M.C., B.Sc., (McGill '13), Gen. Mgr., Dom. Welding Engineering Co. Ltd., P.O. Box 594, Montreal, Que. (*H*) 485 Strathcona Ave., Westmount, Que. (*A.M. 1920*)

♂MacAFEE, Ralph Evans, Major, M.C., B.Sc., (McGill '10), Mgr., Eastern Br., Babcock-Wilcox & Goldie-McCulloch, Ltd., 312 Canada Cement Bldg., P.O. Box 3040, Montreal, Que. (*H*) 4156 Dorchester St. W. (*A.M. 1920*) (*M. 1931*)

McALL, Henry W., Res. Engr., Waterfront Viaduct, Dept. Rys. and Bridges, City of Toronto, City Hall, Toronto, Ont. (*H*) 134 Farnham Ave. (*M. 1913*)

MACALLUM, Andrew Fullerton, B.A.Sc., C.E., (Tor. '96), Cons. Engr., Municipal and Gen. Engrg., 612 Bank St., Ottawa, Ont. (*A.M. 1907*) (*M. 1908*)

McALPINE, Robert F., B.Sc., (N.S.T.C. '28), 93 Cromarty St., Sydney, N.S. (*Jr. 1929*)

McANDREW, Jos. B., B.A.Sc., (Tor. '12), Asst. Designing Engr., Welland Ship Canal, 70 Church St., St Catharines, Ont. (*A.M. 1919*)

McARA, Peter Graham, B.Sc., (Sask. '29), Asst. Supt., W.W. Dept., City of Regina, Sask. (*H*) 179 Angus Cres. (*A.M. 1934*)

♂MACAULAY, Robt. Vernon, Lieut., M.C., B.A.Sc., (Tor. '12), Asst. Vice-Pres., Bell Telephone Co. of Canada, Montreal, Que. (*H*) 727 Roslyn Ave., Westmount, Que. (*M. 1927*)

McARTHUR, Duncan, Principal Engr., Surveyor, British Corp'n. Register of Shipping and Aircraft, 360 Place Royale, Montreal, Que. (*H*) 1374 Sherbrooke St. W. (*M. 1921*)

McARTHUR, Franklin, B.Sc., (Queen's '07), Pres., The McArthur Engineering and Construction Co. Ltd., 15 Douglas St., Guelph, Ont. (*A.M. 1909*) (*M. 1919*)

McAVITY, G. Clifford, T. McAvity Sons, Ltd., Saint John, N.B. (*H*) Rothesay, N.B. (*Affil. 1919*)

MacBRIDE, Duncan, Gen. Mgr., Victoria Cold Storage and Terminal Warehouse Co. Ltd., Odgen Point Docks, Victoria, B.C. (*H*) 661 Newport Ave. (*A.M. 1929*)

McBRIDE, Ernest Willard, B.A.Sc., (Tor. '23), Technical Engr., Abitibi Power and Paper Co., Ltd., Toronto, Ont. (*H*) 86 High Park Ave. (*S. 1920*) (*Jr. 1928*)

McCABE, R. I., B.Sc., (McGill '30), 4914 Grosvenor Ave., Westmount, Que. (*S. 1928*)

♂McCAGHEY, Norman F., Major, D.S.O., M.C., Supt., Price Bros. & Co., Ltd., Box 8, Riverbend, Que. (*S. 1913*) (*Jr. 1920*) (*A.M. 1923*)

McCALL, Alan D., B.Sc., (McGill '24), 619 Clarke Ave., Westmount, Que. (*S. 1923*)

McCALL, Thos. Lockhart, Chief Mining Engr., Dominion Steel and Coal Corp., Ltd., Sydney, N.S. (*H*) 186 Kings Rd. (*M. 1930*)

♂McCAMMON, John Whyte, Lieut., B.Sc., (McGill '13), Consultant, 11 Belfrage Rd., Westmount, Que. (*Jr. 1913*) (*A.M. 1924*)

McCANN, Edward Howard, B.Eng., (McGill '34), Can. Industries Ltd., Brownsburg, Que. (*H*) 2517 Wallace St., Regina, Sask. (*S. 1934*)

McCANN, Wm. Neil, B.Sc., (Man. '34), Water Development Comm., Swift Current, Sask. (*H*) 2517 Wallace St., Regina, Sask. (*S. 1934*)

McCANNEL, D. A. Roy, B.Sc., (Queen's), City Engr., City of Regina, Regina, Sask. (*H*) 2258 Osler St. (*S. 1914*) (*A.M. 1917*) (*M. 1930*)

McCARTHY, Clarence Wilbert, Asst. Engr., Dept. of Highways, Halifax, N.S. (*H*) Falmouth, N.S. (*A.M. 1923*)

MacCARTHY, Henry Blair, B.Sc., (McGill '28), 110 Lisgar St., Ottawa, Ont. (*Jr. 1930*)

♂McCARTHY, Thos. V., B.A.Sc., (Tor. '13), Res. Engr., Dept. Northern Development, Halls Bridge, Ont. (*H*) 11 Lowther Ave., Toronto, Ont. (*A.M. 1919*)

♂McCLELLAND, Harold Langdon, B.A.Sc., (Tor. '17), M.A.Sc., Cons. Engr., 505, 330 Bay St., Toronto, Ont. (*H*) 1044 College St. (*A.M. 1928*)

McCLELLAND, Richard James, 378 Brock St., Kingston, Ont. (*H*) 185 Clergy St. (*S. 1906*) (*A.M. 1915*)

McCLELLAND, W. Raymond, B.Sc., M.Sc., (McGill '23), Met. Engr., Ore Dressing and Metallurgy, Dept. of Mines, Mines Branch, Ottawa, Ont. (*H*) 225 Carling Ave. (*S. 1920*) (*Jr. 1923*) (*A.M. 1929*)

♂McCLINTOCK, G. A., Major, B.A.Sc., (Tor. '24), Engr., Keasbey & Mattison Co., Bell Asbestos Mines Dept., Thetford Mines, Que. (*S. 1914*) (*A.M. 1925*)

McCLUNG, Jos. Eldon, B.Sc., (McGill '26), 50 Wexford Ave. S., Hamilton, Ont. (*S. 1924*)

McCLURE, Lindley W., B.Sc., (McGill '27), a/Municipal Engr., Dist. of Flin Flon, Box 306, Flin Flon, Man. (*S. 1926*) (*Jr. 1928*)

McCLYMONT, Herbert Ross, Member of Firm, McMaster-Jacob Engineering Co. Ltd., 107 Front E., Toronto 5, Ont. (*H*) 157 Pinewood Ave. (*A.M. 1919*)

McCOLL, Gilbert B., B.A., (Man. '02), D.T.S., M.L.S., D.L.S., McColl Bros., 319 Somerset Blk., Winnipeg, Man. (*H*) 167 Lanark St. (*A.M. 1911*)

♂McCOLL, Samuel E., Lieut., B.A., (Man. '07), M.L.S., D.L.S., S.L.S., Director of Surveys, Man., Dept. of Mines and Nat. Res., Winnipeg, Man. (*H*) 178 Langside St. (*Jr. 1916*) (*A.M. 1919*)

McCOLL, Wm. Ross, B.A.Sc., (Tor. '33), 16 Askin Ave., Sandwich, Ont. (*S. 1933*)

♂McCONKEY, Thomas C., Lieut., B.Sc., (McGill), Vice-Pres., B. J. Coghlin Co., Ltd., 3320 Ontario St. E., Montreal, Que. (*H*) 4070 Highland Ave. (*S. 1904*) (*A.M. 1913*)

McCONNELL, S. Bruce, Dist. Engr., C.P.R., North Bay, Ont. (*H*) 86 Wyld St. (*S. 1899*) (*A.M. 1905*) (*M. 1916*)

McCORMACK, D. N., B.Sc., (N.B. '28), B.Sc., (Man. '33), Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*S. 1927*) (*Jr. 1928*)

McCORMICK, A. T., B.Sc., (Man. '30), Oper. Engr., Northern Elec. Co. Ltd., 11th Ave. and Centre St., Calgary, Alta. (*H*) 508-14th Ave. W. (*S. 1928*) (*A.M. 1934*)

McCORMICK, R. S., Gen. Supt. and Chief Engr., Algoma Central Rly., Sault Ste. Marie, Ont. (*H*) 321 E. Spruce St., Sault Ste. Marie, Mich. (*M. 1913*)

♂McCORT, C. Roy, Capt., B.A.Sc., (Tor. '15), 442 Clarke Ave., Westmount, Que. (*Jr. 1919*) (*A.M. 1920*)

McCOUBREY, Jas. Addison, Divn. Engr., Dept. of Northern Development, Kenora, Ont. (*A.M. 1924*)

McCOY, Lyle, Can. Car and Foundry Ltd., 621 Craig St. W., Montreal, Que. (*H*) 97 Brock Ave. N., Montreal West, Que. (*A.M. 1919*)

McCRADY, Louis de Bernier, B.S., C.E., (Clemson), Chief Engr., Canadian Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 24 Richelieu Place (*M. 1921*)

McCRADY, MacH., B.Sc., Chief of Labs., Prov. Bureau of Health, 89 Notre Dame St. E., Montreal, Que. (*H*) 3469 Northcliffe Ave. (*A.M. 1914*)

McCRAE, Donald Gordon, Project Mgr., Southern Okanagan Irrigation Project, Box A, Oliver, B.C. (*A.M. 1925*)

♂MacCRIMMON, Duncan Daniel, Capt., M.C., Box 45, Williamstown, Ont. (*A.M. 1926*)

McCRONE, Donald G., B.A.Sc., (Tor. '27), Control Chemist, E. B. Eddy & Co., Hull, Que. (*H*) 78 Iona Ave., Ottawa, Ont. (*Jr. 1929*) (*A.M. 1934*)

McCRORY, James Alexander, B.S., (Penn. State '07), Vice-Pres. and Chief Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) Apt. C-32, 3940 Cote des Neiges Rd. (*A.M. 1921*) (*M. 1926*) (*Member of Council, E.I.C.*)

♂McCRUDDEN, Harry E., Lieut., Staff Engr., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 734 Upper Belmont Ave., Westmount, Que. (*S. 1913*) (*Jr. 1919*) (*A.M. 1927*)

McCUBBIN, George A., O.L.S., Private Practice, Box 327, Chatham, Ont. (*H*) 40 Lacroix St. (*A.M. 1899*) (*M. 1919*)

McCULLOCH, Andrew, Penticton, B.C. (*M. 1907*)*

McCULLOCH, Andrew L., (Tor. '87), Nelson, B.C. (*A.M. 1891*) (*M. 1909*)

McCULLOCH, Orval James, B.Sc., (McGill '17), Angus Robertson, Ltd., 1406 University Tower Bldg., Montreal, Que. (*S. 1916*) (*A.M. 1927*)

♂McCURDY, L. B., Capt., (N.S.T.C. '13), Chief Engr., Dom Reinforcing Steel Co. Ltd., Clanranald Ave., Montreal, Que. (*H*) 1576 Summerhill Ave. (*A.M. 1920*)

McCURDY, Lyall R., B.Sc., M.Sc., (McGill '27), Lecturer, Mech. Engrg., McGill University, Montreal, Que. (*H*) 647 Milton St. (*S. 1919*) (*Jr. 1926*) (*A.M. 1929*)

McDERMID, George, B.Sc., (Man. '27), Engr., Way and Structures, Winnipeg Electric Co., Winnipeg, Man. (*H*) 576 Sherburn St. (*A.M. 1934*)

MacDERMOTT, Sidney Guy, B.Sc., (McGill '05), Can. Johns-Manville Co. Ltd., 910 St. James St., Montreal, Que. (*H*) 18 Dufferin Rd., Ste. Rose, Que. (*A.M. 1919*)

MacDERMOTT, Kenneth W., B.Sc., (N.B. '30), H.E.P.C. of Ont., Box 17, Port Carling, Ont. (*S. 1930*)

MacDIARMID, Archibald A., B.Sc., (McGill '10), Chief Engr., Price Bros. & Co. Ltd., Quebec, Que. (*H*) 90 de Salaberry Ave. (*S. 1909*) (*A.M. 1914*) (*M. 1926*)

MACDONALD, Albert E., M.Sc., (McGill '22), Assoc. Prof. of C.E., University of Manitoba, Sherbrooke at Portage Ave., Winnipeg, Man. (*H*) 331 Cambridge St. (*S. 1919*) (*Jr. 1922*) (*A.M. 1932*)

McDONALD, Alexander J., 537 Gilbert St., Kingston, Ont. (*S. 1935*)

MACDONALD, Archibald J., B.A., B.Sc., Black Avon, N.S. (*A.M. 1907*)

MacDONALD, Arden M., B.Sc., (N.S.T.C. '33), Can. Carborundum Co. Ltd., 2133 Main St., Niagara Falls, Ont. (*S. 1931*) (*Jr. 1935*)

♂MACDONALD, Arthur C., Lt.-Col., D.S.O., (R.M.C., Kingston), Chairman, Macdonald, Gibbs & Co. (Engineers), Ltd., 28 Finsbury Sq., London, E.C.2, England. (*H*) 9 Walton Place, Knightsbridge, S.W.3. (*M. 1898*)

♂MACDONALD, C. Beverley R., Capt., (R.M.C., Kingston '14), Dir. and Res. Agent in Iraq, Humphreys Ltd., Knightsbridge, London, England Address: P.O. Box 122, Baghdad, Iraq. (*S. 1914*) (*A.M. 1919*) (*M. 1931*)

♂McDONALD, Claude K., Lieut., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 2430 Westhill Ave. (*A.M. 1924*)

MACDONALD, Colin, B.A.Sc., Matachewan Cons. Mines, Matachewan, Ont. (*H*) 453 Victoria Ave., Windsor, Ont. (*S. 1934*)

McDONALD, D. Harold, Asst. Engr., D.P.W., Canada, Halifax, N.S. (*H*) 56 Coburg Rd. (*Jr. 1916*) (*A.M. 1917*)

McDONALD, Donald John, B.Sc., (Queen's '25), Bell Telephone Co. of Canada, Beaver Hall Bldg., Montreal, Que. (*H*) 5149 Earnscliffe Ave. (*Jr. 1930*)

MacDONALD, Geo. Leslie, B.A.Sc., (Tor. '28), 278 Spadina Rd., Toronto, Ont. (*S. 1928*)

♂MacDONALD, Jas. Campbell, Major, M.C., B.E., (Dalhousie '06), Comptroller, Water Rights, Prov. of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 1164 Roslyn Rd. (*S. 1908*) (*A.M. 1912*) (*M. 1923*)

MacDONALD, James Wm., Asst. Refinery Supt., Imperial Oil Ltd., Sarnia, Ont. (*H*) R.R. 3, Sarnia, Ont. (*Jr. 1920*) (*A.M. 1927*)

MACDONALD, Jeremiah James, B.Sc., (McGill '11), Sir Alexander Gibb & Partners, Queen Anne's Lodge, Westminster, London, S.W.1. (*S. 1911*) (*A.M. 1913*) (*M. 1920*)

♂MACDONALD, John A., Lieut., B.Sc., (N.S.T.C. '20), Topographical Engr., Geological Survey, Victoria Memorial Museum, Ottawa, Ont. (*H*) 34 Glen Ave. (*S. 1920*) (*A.M. 1924*)

MACDONALD, John E., B.A.Sc., (B.C. '31), West Kootenay Power and Light Co., So. Slocan, B.C. (*H*) 1018 Barclay St., Vancouver, B.C. (*S. 1929*)

McDONALD, Kenneth Duncan, B.A.Sc., (Tor. '15), Asphalt Sales Engr., Imperial Oil, Ltd., 56 Church St., Toronto, Ont. (*H*) 104 Hillsdale Ave. W. (*A.M. 1920*)

MacDONALD, Murray Vickers, B.Sc., (Sask.), D.L.S., S.L.S., 2144 Decarie Blvd., Montreal, Que. (*S. 1931*) (*Jr. 1932*)

McDONALD, Norman Geddes, B.A.Sc., (Tor. '18), Cons. Engr., Gore, Nasmith & Storrie, 1130 Bay St., Toronto, Ont. (*H*) 38 Old Bridle Path (*Jr. 1919*) (*A.M. 1922*)

MacDONALD, Wm. A., B.Sc., (N.S.T.C. '29), 27 Tain St., Sydney, N.S (*S. 1930*)

MacDONALD, Walter Elwood, City W.W. Engr., Transportation Bldg., Ottawa, Ont. (*H*) 330 Driveway, Ottawa, Ont. (*A.M. 1932*)

MACDONALD, Wm. G., Engr., N.S. Light and Power Co. Ltd., Halifax, N.S (*H*) 80 Larch St. (*A.M. 1929*)

♂MacDONALD, William M. Bell, Lieut., B.Sc., (McGill '07), Elec. Engr., Rammerscales, Lockerbie, Scotland. (*S. 1908*) (*A.M. 1914*)

♂McDONALD, Wm. Sutherland, B.Sc., (Alta. '15), D.L.S., Asst. Engr., Dept. of Rlys. and Canals, Ottawa, Ont. (*H*) 110 Brighton Ave. (*Jr. 1919*) (*A.M. 1923*)

♂MACDONELL, C. K. S., Lt.-Col., Res. Engr., Dept. Public Highways, Ont., 48½ Market Sq., Chatham, Ont. (*H*) 508 King St. W. (*A.M. 1920*)

McDONNELL, Frank, Chairman, Board of Steamship Inspection, Dept. of Marine, Hunter Bldg., Ottawa, Ont. (*H*) 404 Laurier Ave. E. (*M. 1921*)

McDOUGALL, D. H., Col., LL.D., Box 200, Stellarton, N.S. (*M. 1913*)

MacDOUGALL, Duncan Alexander, 7-B Fort Garry Court, Winnipeg, Man (*M. 1920*)

MACDOUGALL, Geo. D., B.Sc., (McGill '95), Cons. Engr., P.O. Box 1565, New Glasgow, N.S. (*A.M. 1901*) (*M. 1909*) (*Life Member*)

McDOUGALL, Geo. K., B.Sc., (McGill '01), McDougall & Friedman, Cons Engrs., 1221 Osborne St., Montreal, Que. (*H*) 1528 Pine Ave. W. (*S. 1904*) (*A.M. 1912*) (*M. 1919*)

McDOUGALL, J. Cecil, B.Sc., B.Arch., (McGill '10), Architect and Engr., 1221 Osborne St., Montreal, Que. (*H*) 68 Rosemount Crescent, Westmount, Que. (*A.M. 1919*)

McDOUGALL, J. F., B.Sc., (Alta. '30), Highway Engr., D.P.W., Alta. (*H*) 9910 103rd St., Edmonton, Alta. (*S. 1928*)

McDOUGALL, J. Lyle, Somerville Paper Boxes, Ltd., Dundas St., London, Ont. (*Jr. 1930*)

McDOUGALL, Stewart R., M.Sc., (B.C. '23), Northern Electric Co., Ltd., Montreal, Que. (*H*) 21 Ellerdale Rd., Hampstead, Que. (*S. 1920*) (*A.M 1927*)

McDOWALL, Robert, C.E., (Tor. '01), O.L.S., Private Practice, 235 W 7th St., Owen Sound, Ont. (*S. 1887*) (*A.M. 1892*) (*Life Member*)

McDUNNOUGH, Philip Nelson, B.Eng., (McGill '33), Shawinigan Water and Power Co., Three Rivers, Que. (*H*) 86 St. Louis Rd., Quebec, Que. (*S. 1933*)

McDUNNOUGH, Ralph B., B.A.Sc., (McGill '95), Chief Engr., Quebec Power Co., 229 St. Joseph St., Quebec, Que. (*H*) 86 St. Louis Rd. (*A.M. 1927*)

McELHANNEY, Thomas Andrew, B.A.Sc., (Tor. '12), D.L.S., B.C.L.S., Supt., Forest Products Laboratories of Canada, Dept. Inter., Ottawa, Ont. (*H*) 132 Broadway Ave. (*A.M. 1922*)

♂McEWEN, Alan B., Major, D.S.O., B.Sc., (McGill '12), (R.M.C., Kingston), Engr., Can. Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4870 Cote des Neiges Rd. (*S. 1910*) (*Jr. 1914*) (*A.M. 1918*)

McEWEN, George G., B.A.Sc., (Tor. '05), Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. Address: Hudson, Ont. (*A.M. 1916*)

McEWEN, Harold James, B.A.Sc., (Tor. '12), Dist. Mgr., Can. Westinghouse Co., Ltd., 320–8th Ave. W., Calgary, Alta. (*H*) 1918–12th St. W. (*A.M. 1921*)

McFARLAND, Walter Irving, B.Sc., (Alta. '29), Elec. Engr., Beauharnois Construction Co., P.O. Box 50, Beauharnois, Que. (*Jr. 1931*)

♂MACFARLANE, Athol Herridge, Major, M.C., 1494 W. 40th Ave., Vancouver, B.C. (*A.M. 1923*)

McFARLANE, John A., B.A.Sc., (Tor. '04), Vice-Pres., Western Bridge Co. Ltd., Hamilton, Ont. (*H*) 258 Aberdeen Ave. (*A.M. 1910*) (*M. 1919*)

MACFARLANE, M. C., B.Sc., Almonte, Ont. (*S. 1887*) (*A.M. 1889*) (*M. 1912*) (*Life Member*)

♂McFARLANE, M. L. D., Capt., Mgr., Bartlane Dept., News Syndicate Co. Inc., 220 E. 42nd St., New York, N.Y. (*H*) 424 East 57th St. (*S. 1913*) (*A.M. 1924*)

♂MacFARLANE, Peter Wm., Supt'g. Engr., Bldgs. and Grounds, McGill University, Montreal, Que. (*H*) 3535 Carleton Rd. (*Affil. 1935*)

♂McFARLANE, William Thompson, Major, (R.M.C., Kingston '08), Asst. Hydr. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Inter., Rm. 427, Public Bldg., Calgary, Alta. (*H*) 602 Rideau Rd. (*S. 1908*) (*Jr. 1913*) (*A.M. 1921*)

♂McFAUL, Wm. Lawrence, Lieut., B.A.Sc., (Tor. '13), City Engr. and Mgr. of Water Works, Bldg. Commr., City of Hamilton, City Hall, Hamilton, Ont. (*H*) 165 Chedoke Ave. (*A.M. 1919*) (*M. 1925*)

McGAAN, Wm. H., Bureau of Economics, C.N.R., Rm. 309, 360 McGill St., Montreal, Que. Address: Box 32, Station B. (*S. 1906*) (*A.M. 1912*)

McGAVIN, Charles James, Chief Engr., Water Rights Br., Dept. Nat. Res., Prov. of Sask., Sherwood Bldg., Regina, Sask. (*H*) 25 Mayfair Apts. (*A.M. 1921*)

McGEE, Henry C., B.Sc., (N.S.T.C. '32), Big Island, Pictou Co., N.S. (*S. 1932*)

McGEE, Leonard D., B.Eng., (McGill '33), Dom. Tire Co., Dom. Rubber Co., Kitchener, Ont. (*H*) 27 Fischer St. (*S. 1933*)

McGILLIS, Lester, B Sc., (McGill '24), Mgr., Beauharnois Divn., Shawinigan Water and Power Co., P.O. Box Y, Valleyfield, Que. (*S. 1922*) (*Jr. 1928*) (*A.M. 1935*)

MACGILLIVRAY, Alexander M., B.Sc., Dist. Engr., C.N.R., Saskatoon, Sask. (*H*) 615–6th Ave. (*A.M. 1904*)

MACGILLIVRAY, Andrew, B.A., B.Sc., (St. Fr. Xav.), N.S.L.S., Asst. Engr., D.P.W., Bellevue Bldg., Halifax, N.S. (*H*) 25 Brenton St. (*A.M. 1916*) (*M. 1921*)

MacGILLIVRAY, John Alex., Greater Winnipeg Sanitary Dist. (*H*) 240 Niagara St., River Heights, Winnipeg, Man. (*Jr. 1917*) (*A.M. 1919*)

MACGILLIVRAY, Malcolm Stuart, B.Sc., (Queen's '23), Engr., T. Pringle & Son Ltd., 420 Coristine Bldg., Montreal, Que. (*H*) Apt. 15, 4100 Cote des Neiges Rd. (*A.M. 1935*)

McGINNIS, Thos. A., B.Sc., (Queen's '09), Sr. Partner, McGinnis & O'Connor, Engrs. and Contractors, Kingston, Ont (*H*) King St. W. (*S. 1908*) (*A.M. 1912*) (*M. 1923*)

McGORMAN, Samuel Ernest, (Tor. '05), Contracting Engr., Can. Bridge Co., Walkerville, Ont. (*H*) 63 Devonshire Rd. (*M. 1921*)

MacGOWAN, Andrew R., Hoboken Mfrs. Rld. Co., Foot of 5th St., Hoboken, N.J. (*S. 1903*) (*A.M. 1909*)

McGOWAN, E. A., R.C.A.F., Camp Borden, Ont. (*H*) 408 Union St., Saint John, N.B. (*S. 1931*)

♂McGRAIL, Thomas Ernest, Mgr., Heating Dept., Crane, Ltd., Montreal, Que. (*H*) 3465 Belmore Ave. (*A.M. 1922*)

McGREGOR, Douglas Robt., B.Eng., (McGill '35), 1441 Drummond St., Montreal, Que. (*S. 1933*)

♂MacGREGOR, J. Grant, Capt., M.S.M., 4551 Nanaimo St., Vancouver, B.C. (*A.M. 1894*) (*M. 1912*) (*Life Member*)

♂McGREGOR, James, Major, D.S.O., C.E., (Glasgow '00), "Gleniffer," Thorn Road, Bearsden, Glasgow, Scotland. (*A.M. 1909*) (*M. 1920*)

MacGREGOR, Jas. G., B.A., B.Sc., Dist. Supt., Can. Utilities Ltd., Vegreville, Alta. (*S. 1929*)

MacGREGOR, Kenneth Roy, B.Sc., (Queen's '25), Foreman i/c., Race Horse Camp, Petawawa, Ont. (*H*) Eganville, Ont. (*A.M. 1934*)

♂McGUINNESS, Wm. Norman, Engrg. Dept., Northern Electric Co. Ltd., Montreal, Que. (*H*) 69 Kings Rd., Valois, Que. (*A.M. 1929*)

McHUGH, Fred. Jos., Chief Dftsman., Bridge and Mech. Divn., Dominion Bridge Co., Ltd., Montreal, Que. (*A.M. 1925*)

McHUGH, John, Res. Engr., Dept. of Fisheries, 427 Winch Bldg., Vancouver, B.C. (*H*) 5837 Elm St. (*A.M. 1918*)

McILQUHAM, W. S., Jr., B.Sc., (Queen's '23), Designing Hydr. Engr., Dom. Engineering Co., Ltd., Lachine, Que. (*H*) 2301 Beaconsfield Ave. (*Jr. 1926*)

McILWAIN, Samuel, Div. Engr., C.N.R., Central Station, Ottawa, Ont. (*H*) 391 Sunnyside Ave. (*A.M. 1920*)

♂McINTEE, Arthur, Res. Engr., Toronto Terminal Rlys. Co., Rm. 402, Union Sta., Toronto, Ont. (*H*) Apt. 69, 21 Sherwood Ave. (*A.M. 1921*)

♂McINTOSH, Ernest Donald, Lieut., B.Sc., (McGill '19), 4555 Wilson Ave., Montreal, Que. (*S. 1914*) (*A.M. 1920*)

McINTOSH, John Cameron, B.Sc., (Queen's '25), Apt. 98, 3411 Northcliffe Ave., Montreal, Que. (*S. 1924*) (*A.M. 1930*)

McINTOSH, J. Harrington, B.A.Sc., (Tor. '23), Wks. Mgr., B.C. Cement Co., Ltd., Bamberton, Tod Inlet P.O., B.C. (*S. 1920*) (*A.M. 1930*)

McINTOSH, D. E., B.Eng., (McGill '33), Lieut., Dept. National Defence, Camp Borden, Ont. (*S. 1932*)

McINTYRE, D. V., B.Sc., McWatters Gold Mines Ltd., Rouyn, Que. (*H*) Okotoks, Alta. (*S. 1930*)

MacISAAC, Vernon W., B.Sc., (Queen's '21), Mech. Engr., Ford Motor Co. of Canada, E. Windsor, Ont. (*H*) 301 Parkview Apts., 400 Giles Blvd., Windsor, Ont. (*S. 1920*) (*A.M. 1927*)

♂MacKAY, Ernest George, Lt.-Col., B.A.Sc., (Tor. '12), O.L.S., D.L.S., Mackay & Mackay, Rm. 504, Imperial Bldg., Hamilton, Ont. (*H*) 96 Herkimer St. (*A.M. 1921*)

♂McKAY, Hugh Alex., B.A.Sc., (Tor. '23), Mang. Dir., London Structural Steel Co., Ltd., London, Ont. (*H*) 1500 Dundas St. (*S. 1921*) (*Jr. 1925*) (*A.M. 1928*)

MacKAY, Ian Norton, B.Eng., (McGill '35), 4375 Montrose Ave., Westmount, Que. (*S. 1935*)

MacKAY, Jas. Arthur, B.Sc., (N.S.T.C. '11), Asst. Engr., Div. Engr.'s Office, C.N.R., Halifax, N.S. (*A.M. 1927*)

MacKAY, James J., O.L.S., MacKay & MacKay, 504 Imperial Bldg., Hamilton, Ont. (*H*) R.R. 2, Freeman, Ont. (*M. 1921*)

♂McKAY, Jas. Kenneth, Lieut., Divn. Engr., Dept. of Highways, N.S., Clyde River, N.S. (*S. 1907*) (*Jr. 1912*) (*A.M. 1920*)

MACKAY, Robert, Supt., City of Calgary, City Hall, Calgary, Alta. (*H*) 718 Boulevard N.W. (*A.M. 1918*)

McKAY, R. Donald, B.Sc., (N.S.T.C. '33), 44 Follen St., Cambridge, Mass. (*S. 1932*) (*Jr. 1935*)

McKEEVER, J. L., B.Sc., (B.C. '30), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 550 Homewood Ave. (*S. 1930*)

†McKENZIE, B. Stuart, B.A., B.Sc., (McGill '01), Secy., Can. Engineering Standards Assoc., Rm. 3064, National Research Bldg., Ottawa, Ont. (*H*) 11 Somerset St. W. (*S. 1902*) (*A.M. 1911*) (*M. 1919*)

P. ♂MACKENZIE, Chalmers Jack, Lieut., M.C., B.E., (Dalhousie), M.C.E., (Harvard), Dean of Engineering, University of Saskatchewan, Saskatoon, Sask. (*H*) 227-5th Ave. (*Jr. 1911*) (*A.M. 1914*) (*M. 1920*)

MacKENZIE, D. G., B.Sc., (McGill '22), Vice-Pres. and Gen. Mgr., Rogers-Majestic Corp. Ltd., 622 Fleet St., Toronto, Ont. (*H*) 214 Russell Hill Rd. (*S. 1920*) (*A.M. 1928*)

MacKENZIE, Howard A., Kaiser-i-Hind, Supt., Can. Lift Truck Co. Ltd., 754 St. Paul St., Montreal, Que. (*H*) 2439 Rushbrooke St. (*A.M. 1909*) (*M. 1914*)

MacKENZIE, Hugh Ross, B.A.Sc., (Tor. '13), Chief Engr., Dept. of Highways, Sask., Regina, Sask. (*H*) 3220 Victoria Ave. (*A.M. 1916*)

♂MACKENZIE, John Allen, Major, D.S.O., (R.M.C., Kingston '09), Div. Engr., C.P.R., Rm. 335, Union Station, Toronto, Ont. Res.: Metropole Hotel. (*Jr. 1912*) (*A.M. 1925*)

MacKENZIE, John Fenwick Fraser, Mgr., Str'l. Dept., Robb Engineering Wks. Ltd., and Local Mgr., Dom. Bridge Co. Ltd., Amherst, N.S. (*H*) 11 Rupert St. (*Jr. 1920*) (*A.M. 1928*)

♂MACKENZIE, John Fraser, Capt., Sr. Instr'man., C.N.R., P.O. Box 221, Edmundston, N.B. (*S. 1914*) (*A.M. 1921*)

♂MACKENZIE, John Percival, Lt.-Col., D.S.O., 2 Bars, C. de G., Gen. Mgr., Western Bridge Co. Ltd., 1st Ave. and Columbia St., Vancouver, B.C. Res.: Vancouver Club. (*A.M. 1920*)

McKENZIE, Ralph B., B.Sc., (Alta. '32), 1230–5th Ave. S., Lethbridge, Alta. (*S. 1932*)

MacKENZIE, Russell George, Asst. Engr., City of Vancouver, City Hall, Vancouver, B.C. (*Jr. 1920*) (*A.M. 1930*)

♂MacKENZIE, Wm. Jas., Lieut., Dftsman., C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 802 North Drive, Fort Garry, Man. (*A.M. 1919*)

♂MACKENZIE, Wm. Langlands, Lieut., B.Sc., (McGill '17), Designing Engr., Dept. of Rlys. and Canals, Churchill, Man. (*S. 1916*) (*A.M. 1924*)

McKENZIE, William L., Mgr., McKenzie Electric Ltd., 706–3rd Ave. S., Lethbridge, Alta. (*H*) 1230–5th Ave. S. (*A.M. 1922*)

McKERGOW, Charles Millar, Major, B.Sc., M.Sc., (McGill '04), Prof., Mech. Engrg., McGill University, Montreal, Que. (*H*) 343 Kensington Ave., Westmount, Que. (*S. 1903*) (*A.M. 1911*) (*M. 1921*)

MACKERRAS, John D., Vice-Pres., First Trust & Savings Bank of Pasadena, Calif. (*S. 1899*) (*A.M. 1900*)

McKIBBIN, K. H., 131 North Court St., Port Arthur, Ont. (*S. 1935*)

MACKIE, Geo. A., B.Sc., (N.B. '35), 223 King St. E., Saint John, N.B. (*S. 1935*)

MACKIE, Geo. M., Box 1601, Lorne St., New Glasgow, N.S. (*S. 1930*)

McKIEL, Harold Wilson, B.A., B.Sc., (Queen's '08 and '12), Brookfield Prof. of Engrg., Mount Allison University, Sackville, N.B. Box 473. (*A.M. 1919*) (*M. 1923*)

McKIEL, W. Le B., B.Sc., (N.B. '31), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. W. (*S. 1932*)

McKILLOP, Vernon Archibald, B.A.Sc., (Tor. '24), Engr., London Public Utilities Comm., London, Ont. (*H*) 497 Baker St. (*Jr. 1926*) (*A.M. 1927*)

McKINNEY, J. Harold, Asst. Engr., Saint John Harbour Comm., Saint John, N.B. (*H*) 29 Mecklenburg St. (*Jr. 1920*) (*A.M. 1926*)

McKINNON, Alex. Huntley, B.Sc., (N.S.T.C. '34), Maritime Tel. and Tel. Co Ltd., New Glasgow, N.S. (*H*) 376 E. River Rd. (*S. 1934*)

MacKINNON, George Douglas, B.A.Sc., (McGill '97), Pres., Rutherford Lumber Co. Ltd., Montreal, Que. (*H*) 65 Portland Ave,, Sherbrooke, Que. (*A.M. 1906*) (*M. 1922*)

♂MACKINNON, John Geo., Lieut., (Tor. '09), Cons. Engr., Box 83, Moncton, N.B. (*H*) 411 Highfield St. (*A.M. 1925*)

♂MacKINNON, Murdoch Ashley, Lieut., B.Sc., (N.B. '13), Hydro. Engr., Hydrographic Survey, Dept. of Marine, Ottawa, Ont. (*H*) 66 Brighton Ave (*S. 1913*) (*A.M. 1921*)

McKINNON, Roderick Will, Chief Engr., D.P.W., Man., Reclam. Br., Rm. 308, Parliament Bldg., Winnipeg, Man. (*H*) 589 McMillan Ave. (*A.M. 1917*)

McKINNON, Ronald Morrison, B.Sc., (N.S.T.C. '12), Asst. Engr., City of Halifax, City Hall, Halifax, N.S. (*A.M. 1921*)

MacKINNON, W. D., B.Sc., (Queen's '25), Supt., Bd. Mill and Steam Plant, Donnacona Paper Co., Donnacona, Que. (*S. 1924*) (*Jr. 1929*) (*A.M. 1934*)

MacKINTOSH, Colin Dugald, Div. Engr., C.P.R., Kenora, Ont. (*H*) 127-4th St. N. (*A.M. 1911*) (*M. 1922*)

MACKINTOSH, Jas., Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 83 Deloraine Ave. (*A.M. 1911*)

♂MACKLEM, Oliver T., B.Sc., (McGill), Prof. of Engrg., Royal Military College, Kingston, Ont. (*H*) 27 Clergy St. W. (*S. 1907*) (*A.M. 1913*)

McKNIGHT, Chas. E. V., B.Sc., (Queen's '33), Lakeshore Gold Mines, Kirkland Lake, Ont. (*H*) 707 King Edward Ave., Ottawa, Ont. (*S. 1933*)

♂McKNIGHT, Robert Cleland, Major, (R.M.C., Kingston '06), County Engr., Grey County, Court House, Owen Sound, Ont. (*H*) 685-2nd Ave. W. (*S. 1906*) (*Jr. 1913*) (*A.M. 1922*)

G.McLACHLAN, Duncan W., B.Sc., (McGill '06), Engr., i/c St. Lawrence Ship Canal and Hudson's Bay Rly. Terminals, Dept. of Railways and Canals, Ottawa, Ont. (*S. 1902*) (*A.M. 1908*) (*M. 1920*)

McLACHLAN, Hugh F., (R.M.C., Kingston '30), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 30 Gladstone Ave. (*S. 1931*)

♂MacLACHLAN, John Gordon, Major, Dist. Engr., Hudson Bay Rly., C.N.R., Drawer 180, The Pas, Man. (*A.M. 1919*)

MACLACHLAN, Wills, B.A.Sc., (Toronto '07), Cons. Engr., 2 Bloor St. E., Toronto, Ont. (*H*) 50 Oakwood Ave. (*M. 1920*)

♂McLAGAN, Thomas Rongie, B.Sc., (McGill '23), Industrial Consultant, P. E. Dufresne, T. R. McLagan & Associates, 204 Bank of N.S. Bldg., Montreal, Que. (*H*) 1610 Sherbrooke St. W. (*S. 1921*) (*A.M. 1926*)

McLAREN, Arthur Anthony, B.Sc., (Queen's '11), D.L.S., Constrn. Supt., Dom. Construction Corp., Ltd., Toronto, Ont. (*H*) 2177 Dawlish Ave., Niagara Falls, Ont. (*A.M. 1920*)

McLAREN, D. L., B.A.Sc., (Tor. '14), Sales Engr., Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*H*) 33 Prince Arthur Ave. (*A.M. 1919*)

♂MacLAREN, Jas. Ferris, Major, M.C., Partner, Gore, Nasmith & Storrie, Bay-Charles Bldg., Toronto, Ont. (*H*) 227 Davisville Ave. (*A.M. 1921*)

McLAREN, John H., B.Sc., (McGill '01), Designing Engr., Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*H*) 3465 Cote des Neiges Rd. (*A.M. 1912*)

♂McLAREN, Wm. Alfred, Lieut., 84 Longworth Ave., Charlottetown, P.E.I. (*A.M. 1923*)

McLAREN, William Frederick, M.E., (Cornell), Chief Dftsman., Can. Westinghouse Co., Hamilton, Ont. (*M. 1918*)

MacLAURIN, Jas. G., B.A.Sc., (Tor. '12), Temiskaming, Que. (*A.M. 1919*)

♂MacLEAN, Chas. Salmon, B.Sc., (N.B. '13), 7 Paddock St., Saint John, N.B. (*A.M. 1928*)

McLEAN, Douglas L., B.Sc., (McGill '09), Asst. Chief Engr., Greater Winnipeg Sanitary Dist., Winnipeg, Man. (*H*) 701 McMillan Ave. (*S. 1904*) (*A.M. 1912*)

McLEAN, Gordon M., B.Sc., (N.S.T.C. '32), c/o Perron Gold Mines Ltd., Pascalis, Que. (*H*) Souris, P.E.I. (*S. 1931*)

McLEAN, Howard J., Production Mgr., Calgary Power Co., Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 629-44th Ave. W. (*Jr. 1920*) (*A.M. 1924*)

♂McLEAN, Norman B., Major, (R.M.C., Kingston '92), Chief Engr., River St. Lawrence Ship Channel, Dept. of Marine, Hunter Bldg., Ottawa, Ont. (*A.M. 1899*) (*M. 1919*)

McLEAN, William A., Cons. Engr., Wynne-Roberts, Son & McLean, Rm. 902, Metropolitan Bldg., 36 King St. E., Toronto, Ont. (*H*) R.R. 2, Pickering, Ont. (*A.M. 1899*) (*M. 1912*)

McLEAN, Wm. Brown, B.Sc., (McGill '99), W. B. McLean & Co., 955 St. James St., Montreal, Que. (*H*) 154-44th Ave., Lachine, Que. (*A.M. 1906*) (*M. 1922*)

McLEISH, John, B.A,. (Tor. '96), Director, Mines Branch, Dept. of Mines, Ottawa, Ont. (*H*) 299 First Ave. (*M. 1923*)

McLENNAN, Allan J., B.Sc., (M.I.T. '30), (M.Sc., '32), Shell Oil Co. of Canada, Ltd., Montreal East, Que. (*A.M. 1933*)

McLENNAN, Gordon Roderick, B.Sc., (McGill '23), C. D. Howe & Co., Public Utilities Bldg., Port Arthur, Ont. (*H*) 80 North High St. (*S 1921*) (*Jr. 1925*) (*A.M. 1931*) (*Sec.-Treas., Lakehead Br., E.I.C.*)

McLENNAN, Kenneth R., B.Sc., (Queen's '06), Asst. Engr., C.N.R., Rm. 433, New Union Station, Toronto, Ont. (*H*) 133 Madison Ave. (*S. 1907*) (*A.M. 1912*)

McLEOD, C. Kirkland, B.Sc., (McGill '13), Keefer Bldg., 1440 St. Catherine St. W., Montreal, Que. (*H*) 656 Belmont Ave., Westmount, Que. (*Jr. 1914*) (*A.M. 1921*) (*Sec.-Treas., Montreal Br., E.I.C.*)

MACLEOD, Ernest M., B.Sc., (N.S T.C '26), J. R. Booth Ltd., 959 Wellington St., Ottawa, Ont. (*Jr. 1930*)

♂MACLEOD, Geo., Res. Engr., D.P.W., Court House, New Westminster, B.C. (*H*) 2426 St. Lawrence St. (*Jr. 1912*) (*A.M. 1920*)

†MacLEOD, Geo. Roderick, B.Sc., (McGill '97), Asst. Chief Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 4056 Trafalgar Rd. (*S. 1897*) (*A.M. 1908*) (*M. 1914*)

♂MacLEOD, Hector John, Major, B.Sc., (McGill '14), M.Sc., (Alta. '16), M.A., Ph.D., (Harvard '21), Prof. of Elec. Engrg., University of Alberta, Edmonton, Alta. (*H*) 2 University Campus. (*M. 1930*)

McLEOD, Henry Waldron, B.A.I., (N.B.), Principal Asst. Engr., Western Lines, C.P.R., Winnipeg, Man. (*H*) Ste. 3, Alcalde Apts. (*A.M. 1913*)

MacLEOD, John Angus, Dftsman., Dom. Iron and Steel Co., Sydney, N.S. (*H*) 33 Trinity Ave. (*A.M. 1931*)

MacLEOD, John W., B.A., B.Sc., (McGill '14), M.A., (St. Fr. Xav. '11), President, Greenwood Coal Co., Ltd., P.O. Box 196, New Glasgow, N.S. (*A.M. 1919*)

MACLEOD, Keith, B.Sc., (McGill '12), Truscon Steel Co., 30 W. Madison Ave., Youngstown, Ohio. (*S. 1912*) (*A.M. 1922*)

McLEOD, Simon Fraser, Inspr. of Boilers and Machinery, Alta., Public Works Bldg., Lethbridge, Alta. (*H*) 533-14th St. S. (*A.M. 1934*)

McLEOD, Wilson Churchill, B.Sc., (N.S.T.C. '30), (M.E. '34), c/o Lamaque Gold Mines, Ltd., Bourlamaque, Que., Via Amos, Que. (*S. 1930*)

MacMAHON, James W., 614 Grosvenor Ave., Westmount, Que. (*S. 1909*) (*A.M. 1913*)

McMAHON, John Leonard, B.Sc., (Man. '28), Dftsman., C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 557 Mountain Ave. (*Jr. 1928*)

♂McMANUS, M. H., Lieut., Contractor, 290 Tower Rd., Halifax, N.S. (*Affil. 1926*)

McMASTER, Alexander T. C., B.A.Sc., (Tor. '03), Pres., McMaster-Jacob Engineering Co. Ltd., 107 Front St. E., Toronto, Ont. (*H*) 17 Lyall Ave. (*M. 1917*)

McMASTER, Arthur W., B.Sc., (McGill '09), 629 Clarke Place, Westmount, Que. (*S. 1899*) (*A.M. 1909*) (*M. 1929*)

McMATH, A. A. B., B.Eng., (McGill '34), 129 Edison Ave., St. Lambert, Que. (*S. 1934*)

McMATH, Francis C., B.Eng., 1824 Union Guardian Bldg., Detroit, Mich. (*H*) 1037 Iroquois Ave. (*M. 1904*)

McMILLAN, David, Surveys Engr., Geodetic Survey of Canada, Ottawa, Ont. (*H*) 124 Ossington Ave. (*A.M. 1921*)

McMILLAN, Herbert William, Works Mgr., Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 25-41st Ave. (*A.M. 1921*)

McMILLAN, Jas., B.Sc., (Alta. '24), Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 3046-5th St. S.W., Calgary, Alta. (*A.M. 1934*) (*Sec.-Treas., Calgary Br., E.I.C.*)

MacMILLAN, Kenneth L., Chief Dftsman., Canada Cement Co. Ltd., Montreal, Que. (*H*) 235 Lazard Ave., Town of Mount Royal, Que. (*A.M. 1930*)

McMILLAN, Ralph E., B.Sc., (McGill '26), Plant Engr., The British Rubber Co. of Canada, Ltd., St. Laurent, Que. (*H*) Apt. 21, 3410 Atwater Ave., Montreal, Que. (*S. 1922*) (*Jr. 1930*)

McMILLEN, Thomas Wilson, B.Sc., (Penn. '08), Rating Engr., Penn. Rating and Inspection Bureau, Box 46, Harrisburg, Pa. (*A.M. 1915*)

McMORDIE, R. C., B.Sc., (Tor.), Strl. Designing Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 35 Montye Ave. (*S. 1930*)

McMULLEN, Wm. F., B.A.Sc., (Tor. '35), 132 Close Ave., Toronto, Ont. (*S. 1933*)

♂McMURTRY, Lawrence Carleton, Lieut., B.A.Sc., (Tor. '22), Supt. of Erection, Horton Steel Wks., Ltd., Bridgeburg, Ont. (*H*) Box 153, Fort Erie N., Ont. (*A.M. 1927*)

MacNAB, Ira P., S.B., (N.S.T.C.), Commr., Bd. of Commrs. of Public Utilities, Capitol Bldg., Halifax, N.S. Address: Wallace, N.S. (*M. 1919*)

MACNAB, John J., B.Sc., (McGill '06), Private Practice, Engr. and Contracting, Trenton, Ont. (*S. 1904*) (*A.M. 1907*)

MacNAB, S. D., i/c C.E. Testing Lab., McGill University, Montreal, Que. (*H*) 900 Sherbrooke St. W. (*A.M. 1918*)

MACNABB, Thomas Creighton, B.A., (Man. '02), Gen. Supt., C.P.R., Saint John, N.B. (*H*) Rothesay, N.B. (*A.M. 1908*) (*M. 1926*)

♂†McNAUGHTON, A. G. L., Major-Gen., C.B., C.M.G., D.S.O., M.Sc., (McGill '12), LL.D., Pres., National Research Council, Sussex St., Ottawa, Ont. (*H*) 333 Chapel St. (*A.M. 1914*) (*M. 1927*)

♂MACNAUGHTON, Moray F., B.Sc., (McGill '22), Cons. Engr., Milton Hersey Co. Ltd., 980 St. Antoine St., Montreal, Que. (*S. 1920*) (*Jr. 1926*) (*A.M. 1932*)

MacNEARNEY, Charles Allen, Divn. Engr., Provincial Highways Bd., Halifax, N.S. (*H*) Windsor Junction, N.S. (*S. 1909*) (*Jr. 1912*) (*A.M. 1916*)

McNEICE, L. G., B.Sc., (Queen's '13), Engr., Orillia Water, Light and Power Comm., Orillia, Ont. (*H*) 15 Tecumseh St. (*S. 1913*) (*A.M. 1919*)

♂McNICOL, James Arthur, Capt., Estimating Engr., Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 72 Gormley Ave. (*M. 1920*)

MacNICOL, Nicol, B.A.Sc., (Tor. '19), Commr. of Works, Forest Hill Village, 333 Lonsdale Rd., Forest Hill Village, Ont. (*H*) 18 Elderwood Dr. (*S. 1919*) (*Jr. 1923*) (*M. 1935*)

♂McNICOLL, Arthur Edward, Eastern Can. Repres., Atlas Preservative Co. (Erith, Kent, England), 1440 St. Catherine St. W., Montreal, Que. (*H*) 2429 Mariette Ave. (*S. 1921*) (*A.M. 1925*)

McNIVEN, John J., B.Sc., (McGill '12), Sales Engr., General Supply Co. of Canada, Ltd., 653 Craig St. W., Montreal, Que. (*H*) 4430 St. Catherine St. W., Westmount, Que. (*A.M. 1921*)

MACNUTT, Erskine K., B.Sc., (McGill '23), Malpeque, P.E.I. (*S. 1921*) (*Jr. 1927*)

♂MACPHAIL, Alexander, Col., C.M.G., D.S.O., LL.D., B.Sc., (McGill '93), Prof., Gen. Engrg., Queen's University, Kingston, Ont. (*H*) 50 Clergy St. (*M. 1906*)

McPHAIL, Alex. Lyall, B.A.Sc., (Tor. '14), W.W. Supt., Waterworks Comm., City of St. Catharines, Ont. (*H*) 52 York St. (*A.M. 1928*)

♂McPHAIL, D. S., Capt., B.Sc., (McGill '20), c/o Barclay's Bank, 29 Gracechurch St., London, E.C.3, England. (*S. 1913*) (*Jr. 1920*) (*A.M. 1926*)

MacPHAIL, Gordon M., B.Sc., (N.B. '26), Dept. National Defence, Fredericton, N.B. (*S. 1926*) (*A.M. 1930*)

♂MACPHAIL, Jeffrey Burland, Capt., B.A., B.Sc., (McGill '21), C.E., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 3117 Daulac Rd. (*A.M. 1920*)

MACPHAIL, John Goodwill, B.A., B.Sc., (Queen's '05), Commr. of Lights, Marine Dept., Ottawa, Ont. (*H*) 445 Albert St. (*S. 1904*) (*A.M. 1910*) (*M. 1922*)

†MACPHAIL, Wm. Matheson, B.A.Sc., (McGill '98), 15 Edmonton St., Winnipeg, Man. (*S. 1897*) (*A.M. 1901*) (*M. 1916*)

McPHERSON, Alex. Ferrier, B.Sc., (Alta. '27), Engrg. Dftsman., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 112 Wentworth St. S. (*Jr. 1931*)

MacPHERSON, Duncan, Lieut.-Col., (R.M.C., Kingston), Gen. Cons. Engr., 28 Oswald Cres., Toronto, Ont. (*M. 1887*) (*Life Member*)

MACPHERSON, D. C., B.Sc., (Queen's '24), Engr., Warden King Ltd. (Crane), 2104 Bennett Ave., Montreal, Que. (*H*) Apt. 19, 3417 Patricia Ave. (*S. 1922*)

McPHERSON, Fred. G., Alexandra Ave., Bridgewater, N.S. (*A.M. 1907*)

MACPHERSON, Fred Liddell, Office Engr., D.P.W., B.C., Court House, New Westminster, B.C. (*H*) 1825 W. 14th Ave., Vancouver, B.C. (*A.M. 1909*) (*M. 1913*)

MACPHERSON, H. Nolan, B.A.Sc., (Tor. '14), Mgr., Permanent Timber Products, Ltd., Pacific Bldg., Vancouver, B.C. (*H*) 5825 Carnarvon St. (*A.M. 1917*)

MacPHERSON, John Miles, B.Sc., (N.B. '33), North Devon, N.B. (*S. 1934*)

McPHERSON, Ross Cody, B.Sc., (Alta. '32), 10017-114th St., Edmonton, Alta. (*S. 1932*)

♂MacQUARRIE, Edison Malcolm, B.A.Sc., (Tor. '24), O.L.S., Private Practice, 622 Queen St. E., Sault Ste. Marie, Ont. (*H*) 149 Leo Ave. (*S. 1920*) (*A.M. 1927*)

♂McQUEEN, Andrew W. F., B.A.Sc., (Tor. '23), C.E. '32, Asst. Engr., H. G. Acres & Co., Ltd., Cons. Engrs., Niagara Falls, Ont. (*H*) 2250 Dawlish Ave. (*S. 1920*) (*Jr. 1927*) (*A.M. 1929*)

McQUEEN, Duncan Roderick, B.A.Sc., (Tor. '32), 46 Yorkshire St., Guelph, Ont. (*H*) R.R. 2, Collingwood, Ont. (*S. 1930*)

MacRAE, Alexander Ernest, B.Sc., (Queen's '14), Cons. Engr. and Patent Solicitor, 56 Sparks St., Ottawa, Ont. (*H*) 172 Fourth Ave. (*A.M. 1921*)

McRAE, John Bell, B.A.Sc., (McGill '98), Cons. Engr., 321 Ottawa Electric Bldg., Ottawa, Ont. (*H*) 414 Albert St. (*A.M. 1904*) (*M. 1916*)

MACREDIE, J. R. C., B.Sc., (N.B. '31), 752 King St., Fredericton, N.B. (*S. 1931*)

♂MacROSTIE, Norman Barry, Lieut., B.A., B.Sc., (Queen's '11), O.L.S., Cons. Engr., 193 Sparks St., Ottawa, Ont. (*H*) 46 Bellwood Ave. (*A.M. 1921*)

♂McVEAN, Harold Gordon, Lt.-Col., B.A.Sc., (Tor. '02), Consultant, 59 Yonge St., Toronto, Ont. (*H*) 12 Edmund Ave. (*A.M. 1912*) (*M. 1928*)

♂McWILLIAM, Archibald, Str'l. Dftsman, Whitehead & Kales, River Rouge, Mich. (*H*) 12393 Wark Ave., Detroit, Mich. (*A.M. 1931*)

MADDEN, Maurice Stuart, B.Sc., (Queen's '13), Hydro. Survey, Dept. of Marine, Ottawa, Ont. (*A.M. 1920*)

MADDOCK, Chas. Orvill, B.A.Sc., (Tor. '18), Designing Dftsman, International Nickel Co., Box 250, Copper Cliff, Ont. (*A.M. 1926*)

MADELEY, W. A., B.A.Sc., (B.C. '32), 4359-11th Ave. W., Vancouver, B.C. (*S. 1928*) (*Jr. 1934*)

MAGIE, Louis DeWitt, Works Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 371 Reid St. (*M. 1920*)

MAGOR, Philip Douglas, B.Sc., (McGill '30), Power Tester, Southern Canada Power Co., Montreal, Que. (*H*) 4854 Wilson Ave., N.D.G. (*S. 1927*) (*Jr. 1933*)

MAGRATH, Charles Alexander, LL.D., (Tor. '26), Chairman, Can. Section, Intern. Joint Comm. (*H*) 398 Wilbrod St., Ottawa, Ont. (*M. 1917*)

MAGUIRE, Hugh Christopher, Jr. Engr., Welland Ship Canal, St. Catharines, Ont. (*H*) 128 James St. (*A.M. 1921*)

♂MAGWOOD, Wm. Herbert, Col., Town Engr., 168 Pitt St., P.O. Drawer 1089, Cornwall, Ont. (*H*) 128 Second St. E. (*A.M. 1905*) (*M. 1919*)

MAHON, A. G., B.Sc., (N.S.T.C. '29), 21 Bloomingdale Terrace, Halifax, N.S. (*S. 1929*)

♂MAHON, Harry Wendell, B.Sc., (N.S.T.C. '14), Invest. Engr., N.S. Power Comm., P.O. Box 1192, Halifax, N.S. (*H*) 41 Preston St. (*Jr. 1916*) (*A.M. 1918*)

MAILHIOT, A., (Ecole Polytech., '10), D.Sc., '35, Prof. of Mining, Geology and Metallurgy, Ecole Polytechnique, Montreal, Que. (*H*) 4174 Oxford Ave. (*M. 1934*)

MAIN, Daniel Todd, Vice-Pres. and Sec.-Treas., Adanac Supplies Ltd.; Vice-Pres., Can. Waugh Equipment, 974 St. Antoine St., Montreal, Que. (*H*) 35 Aberdeen Ave., Westmount, Que. (*M. 1917*)

♂MAIN, Thos. C., Lieut., C. de G., Engr., Water Supply, C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 136 Lawndale Ave., Norwood, Man. (*A.M. 1917*)

MAIR, R. C., B.Sc., (Alta. '34), Flying Officer, R.C.A.F. Station, Trenton, Ont. (*S. 1932*)

MALCOLM, Alvin Lawrence, B.A.Sc., (Tor. '11), Res. Engr. and Constrn. Supt., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*A.M. 1921*)

♂MALCOLM, Wm. Lindsay, Lt.-Col., M.A., B.Sc., (Queen's '07), M.C.E., O.L.S., D.L.S., Prof. Municipal Engrg., Queen's University, Kingston, Ont. (*S. 1907*) (*A.M. 1909*) (*M. 1920*)

MALLOCH, Norman, B.Sc., (Queen's '12), Project 150, Dept. National Defence, Madawaska, Ont. (*H*) Arnprior, Ont. (*A.M. 1919*)

MALONE, Willis P., B.Sc., (McGill '25), Northern Electric Co. Ltd., Montreal, Que. (*H*) 1366 Greene Ave., Westmount, Que. (*S. 1925*) (*Jr. 1929*)

MANNING, Ralph Clark, B.A.Sc., (Tor. '17), Dist. Engr., Can. Institute of Steel Construction, 710 Bank of Hamilton Bldg., Toronto, Ont. (*H*) 37 Willowbank Blvd. (*A.M. 1930*)

MANNING, Walter J., B.A.Sc., (Ecole Polytech., Montreal '27), Colonization Dept., Parliament Bldg., Quebec, Que. (*H*) 167 Cremazie St. (*S. 1929*)

MANOCK, Wilbur R., B.Sc. in C.E., (Illinois '10), Mgr. of Operations, Horton Steel Wks., Fort Erie N., Ont. (*H*) 26 Wintemute St. (*A.M. 1927*)

♂MANSBRIDGE, Alf. S., Lieut., Engrg. Dept., Pacific Mills Ltd., Box 344, Ocean Falls, B.C. (*Jr. 1929*) (*A.M. 1922*)

♂MANSON, Alex. B., Lieut., B.A.Sc., (Tor. '10), Gen. Mgr., Public Utilities Comm., 7-9 Ontario St., Stratford, Ont. (*H*) 107 Caledonia St. (*S. 1910*) (*A.M. 1914*) (*M. 1925*)

MANSON, George J. (Tor. '13), Development Counsel, Hawkesbury, Ont. (*A.M. 1928*)

MANZER, Ronald Wendell, B.Sc., (N.B. '34), Nashwaak Bridge, N.B (*S. 1934*)

MARBLE, Wm. O., Partner, Hodgson, King & Marble, 1401 Main St., Vancouver, B.C. (*M. 1919*)

MARCHAND, E. F., D.L.S., Mgr., Laurentian Hydro-Electric Ltd., St. Jerome, Que. (*Jr. 1925*)

MARCOTTE, Pacifique, B.A.Sc., (Ecole Polytech., Montreal '20), Designing Engr., D.P.W. and L., Quebec, Que. (*H*) 27 Laurentide Ave. (*A.M. 1932*)

MARR, Norman, B.A.Sc., C.E., (Tor. '12), Chief Hydr. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) 347 Stewart St. (*S. 1909*) (*Jr. 1911*) (*A.M. 1916*) (*M. 1928*)

MARROTTE, Louis Henry, B.Sc., (McGill '04), Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 3872 Melrose Ave. (*A.M. 1920*) (*M. 1922*)

MARSH, K. H., B.A., (Penn. State '09), Chief Engr., Dominion Steel and Coal Corp., Ltd., Sydney, N.S. (*M. 1921*)

MARSHALL, Adam Scott, Address unknown. (*S. 1929*)

♂MARSHALL, Irvine Meredith, Capt., M.C., B.Sc., (Queen's '21), Gen. Supt., Reno Gold Mines, Ltd., Salmo, B.C. (*A.M. 1921*)

♂MARSHALL, J. A. P., B.A.Sc., C.E., (Tor.), Dist. Engr., Dept. Public Highways, Parliament Bldgs., Toronto, Ont. (*H*) 512 Riverside Drive. (*Jr. 1912*) (*A.M. 1916*)

MARSHALL, Lawrence Jas., B.Sc., (Man. '35), Ashern, Man. (*S. 1935*)

MARSHALL, M. Hill, c/o Water Rights Branch, Sask., Regina, Sask. (*A.M. 1911*) (*M. 1916*)

MARSTON, Guy Reeves, County Engr. of Norfolk, Court House, Simcoe, Ont. (*H*) 57 Norfolk St. N. (*A.M. 1921*)

MARTIN, Colin H., B.Sc., (Man. '34), Selkirk, Man. (*S. 1935*)

♂MARTIN, Edward Byron, Lieut., B.Sc., (N.B. '12), City Engr., City of Moncton. (*H*) 35 Cameron St., Moncton, N.B. (*A.M. 1920*)

MARTIN, Edward Newcome, B.Sc., (McGill '05), 4804 Victoria Ave., Montreal, Que. (*M. 1932*)

MARTIN, Frank John Ellen, B.Sc., (Sask. '28), Str'l. Engr., Frank P. Martin, Arch., 315 Avenue Bldg., Saskatoon, Sask. (*Jr. 1931*)

♂MARTIN, Lawrence Thos., Lt-Col., D.S.O., Vice-Pres. and Mang. Dir., Gleeson Martin Ltd., 519 Ottawa Electric Bldg., Ottawa, Ont. (*H*) 267 Somerset St. W. (*M. 1921*)

MARTIN, Lucien, B.A.Sc., (Ecole Polytech., Montreal '31), Bridge Constrn. Engr., D.P.W., Parliament Bldgs., Quebec, Que. (*H*) Apt. 4, 5 Belvedere St. (*Jr. 1932*) (*A.M. 1934*)

MARTIN, R. L., B.Eng., (McGill '33), Ford Motor Co. of Canada Ltd., Montreal, Que. (*H*) Apt. 5, 2430 Lincoln Ave. (*S. 1931*)

MARTINDALE, E. S., B.A.Sc., (Tor. '11), D.L.S., Dom. Fuel Bd., Victoria Memorial Museum, Ottawa, Ont. (*H*) 308 Manor Rd., Rockcliffe Park. (*A.M. 1919*)

MARTINEAU, Jos. Omer, B.Sc., (Queen's '15), Asst. Chief Engr., Roads Dept., Que., Quebec, Que. (*H*) Apt. 104, Chateau St. Louis, Grande Allée. (*M. 1935*)

♂MASON, Frank H., Lieut., R.N.V.R., Asst. Str'l. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 449 Annette St. (*A.M. 1921*)

MASON, G. A. R., B.Sc., (Alta. '34), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*S. 1934*)

MASON, Orley B., B.Eng., (McGill '33), Imperial Oil Co., Sarnia, Ont. (*H*) 114 Blanche St. (*S. 1933*)

MASSE, Fernand Andre, B.A.Sc., (Tor. '31), Asst. Chem., Abitibi Power and Paper Co., Sault Ste. Marie, Ont. (*H*) 301 Beverley St. (*Jr. 1932*)

MASSEY, Denton, B.Sc., (M.I.T. '24), 372 Bay St., Toronto, Ont. (*H*) 34 Alexandra Wood. (*S. 1920*) (*A.M. 1930*)

MASSUE, Huet, B.A.Sc., (Ecole Polytech., Montreal '13), Asst. Engr., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 3815 St. Hubert St. (*S. 1912*) (*A.M. 1918*)

MATHER, K. R., B.Sc., (Queen's '29), 66 Havelock St., Toronto, Ont. (*S. 1928*)

♂MATHER, Richard H., Lieut., B.Sc., (McGill '13), Elec. Engr., Shawinigan Water and Power Co., Montreal, Que. (*H*) 5583 Queen Mary Rd. (*A.M. 1919*)

MATHER, William Allan, B.Sc., (McGill '08), Gen. Mgr. of Western Lines, C.P.R., Winnipeg, Man. (*H*) 103 Handsart Blvd., Tuxedo, Man. (*A.M. 1911*) (*M. 1920*)

MATHESON, Arthur J., (R.M.C., Kingston), Sr. Hydr. Engr., Dom. Water Power and Hydrometric Bureau, 81 Metcalfe St., Ottawa, Ont. (*S. 1895*) (*A.M. 1899*) (*M. 1910*)

MATHESON, J. H. Parks, B.Sc., (McGill '30), Chem. Engr., Plant Research Dept., Shawinigan Chemicals Ltd., Shawinigan Falls, Que. (*H*) 92-A 4th St. (*S. 1928*)

MATHESON, J. S., B.Sc., (N.S.T.C. '34), 327 South St., Halifax, N.S. (*S. 1930*)

MATHEWS, Henry Menns, Merz & Partners, 32 Victoria St., London, S.W.1, England. (*A.M. 1930*)

MATHIESON, John Richard, 642 Walker Ave., Winnipeg, Man. (*S. 1935*)

MATHIESON, T. S., B.Sc., (Queen's '26), Designing Mech. Engr., Falconbridge Nickel Mines, Ltd., Box 193, Falconbridge, Ont. (*Jr. 1928*)

MATTHEWS, Samuel, B.Sc., (Sask. '28), Ceramic Engr., Dom. Fire Brick and Clay Products Ltd., Claybank, Sask. (*H*) 704 Saskatchewan Cres. E., Saskatoon, Sask. (*A.M. 1935*)

MATTICE, E. S., B.A.Sc., Boucherville, Que. (*S. 1887*) (*A.M. 1895*) (*M. 1902*) (*Life Member*)

MATTSON, Raymar John, B.Sc., (R.T.C., Stockholm '20), Engr., Foundation Co. of Canada, Ltd., Montreal, Que. (*H*) 4864 Cote des Neiges Rd., Apt. 11. (*A.M. 1934*)

MAUDE, John Henry, Chief Designer, M.M. and P.M. Dept., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 657 Allard St., Verdun, Que. (*A.M. 1934*)

MAXIMOFF, Sergius P., Pet. St., 79, Bolchoi pr. Leningrad, U.S.S.R. (*A.M. 1903*) (*M. 1910*)

♂MAXWELL, Edward G., B.Sc., (Dalhousie '22), B.Sc., (McGill '24), Efficiency Engr., Pittsburgh Plate Glass Co., Creighton, Pa. (*H*) 387 California Ave., Oakmont, Pa. (*S. 1923*) (*Jr. 1927*) (*A.M. 1930*)

♂MAXWELL, Marvin Wilbur, Major, M.C., B.Sc., (N.B. '12), Indust. Commr., C.N.R., 1400 Woolworth Bldg., New York, N.Y. (*H*) 3900 Greystone Ave. (*A.M. 1919*)

MAYEROVITCH, Robt., B.Eng., (McGill '33), Rockland, Ont. (*S. 1933*)

MAYHEW, Earle Chandler, (R.M.C., Kingston '34), Lieut., O.M.E., M.D. No. 3, Kingston, Ont. (*H*) 536 Fairford St. E., Moose Jaw, Sask. (*S. 1935*)

MC—see under MAC

♂MEADD, Howard E., B.Sc., (Queen's '21), Plant Engr. and Mech. Supt., Howard Smith Paper Mills, Ltd., Cornwall, Ont. (*H*) 214 Bedford St. (*S. 1920*) (*A.M. 1923*)

♂MEADE, John Campbell, Lieut., Ste. D, 1818 Scarth St., Regina, Sask. (*A.M. 1918*)

MEADOWS, William Walter, (Tor. '95), Sask. and Dom. L.S., Gov't. Surveyor, Dept. Highways, Sask., Maple Creek, Sask. (*M. 1922*)

MEALS, Casper D., Wire Rope Engr., B. Greening Wire Co. Ltd., Hamilton, Ont. (*H*) 233 Hillcrest Ave. (*M. 1935*)

♂MECHIN, Frederick Charles, Capt., B.A.Sc., (Tor. '14), Mgr., Montreal Refinery, Imperial Oil Ltd., Box 1510, Montreal, Que. (*H*) 11844 Notre Dame St., Pointe aux Trembles, Que. (*A.M. 1917*)

♂MEDFORTH, Geo. T., Lieut., Mang. Engr., Canada Electric Co., Ltd., Amherst, N.S. (*A.M. 1923*)

♂MEDLAR, George Elmer, Asst. Engr., Essex Border Utilities Comm., Windsor, Ont. (*H*) 219 Hanna St. W., Windsor, Ont. (*Jr. 1922*) (*A.M. 1930*)

MEEHAN, Owen Michael, B.Sc., (N.S.T.C. '29), c/o Hydrographic Survey, Hunter Bldg., Ottawa, Ont. (*A.M. 1932*)

♂MEEK, Victor M., Lieut., B.Sc., (McGill '10), Asst. Dir., Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) 181 Gilmour St (*A.M. 1914*) (*M. 1925*)

MELDRUM, Wm., Mine Surveyor, Lethbridge Collieries Ltd., Lethbridge, Alta. (*H*) 329–14th St. (*A.M. 1925*)

MELLOR, Alfred A., M.Sc., The Nichols Chemical Co., Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 619 Belmont Ave., Westmount, Que. (*A.M. 1909*)

MELLOR, Alfred Geoffrey, B.Eng., (McGill '34), 619 Belmont Ave., Westmount, Que. (*S. 1932*)

MELLOR, John Harold, B.Sc., (McGill '30), Field Engr., Can. Copper Refiners, Ltd., P.O. Box 489, Montreal, Que. (*H*) 619 Belmont Ave., Westmount, Que. (*S. 1930*) (*Jr. 1934*)

MELSTED, Valdimar J., Vice-Pres., Milton Hersey Co., Ltd., Salmon Arm, B.C. (*S. 1910*) (*A.M. 1913*)

MENDELSOHN, L., B.Eng., (McGill '33), 2086 Tupper St., Montreal, Que. (*S. 1933*)

MENGES, Edwin A. H., Chief Engr., Disher Steel Construction Co. Ltd., 80 Commissioners St., Toronto 2, Ont. (*H*) 40 Strathearne Blvd., Forest Hill. (*A.M. 1930*)

MERRETT, E. J., B.C. Nickel Mines, Choate, B.C. (*H*) Mount Tomlie P.O., Victoria, B.C. (*S. 1930*)

MERSHON, Ralph D., M.E., D.Sc., Pickwick Arms Hotel, Greenwich, Conn. (*M. 1904*)

MESSENGER, W. A., B.Sc., (McGill '22), 363 Melville Ave., Westmount, Que. (*S. 1920*) (*A.M. 1928*)

MÉTHÉ, Philippe, B.A., C.E., (Ecole Polytech., Montreal '15), Principal, Quebec Technical School, 185 Blvd. Langelier, Quebec, Que. (*S. 1913*) (*A.M. 1928*)

MEUSER, Henry Lloyd, (R.M.C., Kingston '34), B.Sc., (Queen's '35), Lieut., R.C.E., Dept. National Defence, Ottawa, Ont. (*S. 1935*)

♂MEWS, John Courtenay, Constrn. Engr., Buchans Mining Co., Ltd., Buchans, Nfld. (*Jr. 1921*)

MIALL, Edward, Jr., Engr., (Q.E.R.), Dept. of National Defence, Rm. 605, Woods Bldg., Ottawa, Ont. (*Jr. 1934*)

MICHAUD, J. Arthur, D.P.W., Parliament Bldgs., Toronto, Ont. (*A.M. 1923*)

MICHAUD, Andre, B.A.Sc., (Ecole Polytech., Montreal '34), 3582 St. Famille St., Montreal, Que. (*S. 1934*)

♂MICHIE, Victor, Capt., Mang. Dir., Foley Bros., Ltd., 719 McIntyre Blk., Winnipeg, Man. (*H*) Ste. 21, The Bronx, River Ave. (*A.M. 1909*) (*M. 1921*)

MICKLETHWAITE, W. E., B.A.Sc., (Tor. '32), Dept. of Mining Engrg., University of Toronto, Toronto, Ont. (*H*) 886 Ossington Ave. (*S. 1932*)

MIDDLETON, Oliver, Wayside, Fernhurst, Nr. Haslemere, Surrey, England (*S. 1930*)

MIDGLEY, Frank H., A.R.T.C. (Glasgow), Engr., L.E. & N. & G.R. Rlys., Preston, Ont. (*H*) 78 Water St., Galt, Ont. (*S. 1907*) (*Jr. 1912*) (*A.M. 1921*) (*M. 1926*)

MIDGLEY, Geo. Henry, B.Sc., (Mt. Allison '22), B.Sc., (N.S.T.C. '24), Sales Engr., Dodge Mfg. Co. of Canada, Ltd., 774 St. Paul St. W., Montreal, Que. (*Jr. 1928*)

MIESCHER, W. A., C.E., (Fed. Polytech., Zurich), i/c Constrn. 1st Sec. Rhine Regulation, Rheinbauamt, Freiburg, Germany. (*H*) 22 Silberbachstrasse, Freiburg. (*A.M. 1928*)

♂MIÉVILLE, A. L., Lt.-Col., D.S.O., M.C., Cudlow House, Rushington, Sussex, England. (*A.M. 1911*) (*M. 1924*)

MIFFLEN, Sydney C., B.Sc., (McGill '14), Office Engr. and Chief Mine Surveyor, Dom. Coal Co. Ltd., Glace Bay, N.S. (*H*) 60 Whitney Ave., Sydney, N.S. (*Jr. 1918*) (*A.M. 1920*) (*M. 1930*) (*Sec.-Treas., Cape Breton Br., E.I.C.*)

MILES, Edgar S., B.Sc., (N.B. '04), Engr., A. W. Robertson Ltd., Ft. of Spadina Ave., Toronto, Ont. (*H*) 200 Riverside Dr. (*A.M. 1911*)

†MILES, Edmund Lancelot, 4 Cavendish Apts., Charlottetown, P.E.I. (*A.M. 1907*) (*M. 1918*)

MILES, Harold Roy, Div. Engr., C.P.R., Moose Jaw, Sask. (*A.M. 1902*) (*M. 1919*)

MILLAR, Peter, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 57–24th Ave., Lachine, Que. (*A.M. 1931*)

MILLARD, Clarence Stephen, Freshford, Nr. Bath, Somerset, England. (*A.M. 1921*)

MILLER, Alex. M., B.Sc., (N.S.T.C. '34 and '35), New Waterford, N.S. (*S. 1935*)

MILLER, Charles, B.Sc., (Queen's '30), Duke-Price Power Co. Ltd., Arvida, Que. (*S. 1928*) (*A.M. 1935*)

MILLER, D. C. R., B.A.Sc., (Tor. '35), 1 Castle Frank Drive, Toronto, Ont. (*S. 1932*)

MILLER, Donald Waters, B.Sc., (Man. '35), Prairie Cities Oil Co., Ltd., Winnipeg, Man. (*H*) 616 Ashburn St. (*S. 1935*)

MILLER, E. Carlyle, Dir., T. Pringle & Son Ltd., 420 Coristine Bldg., Montreal, Que. (*A.M. 1921*)

MILLER, G. Grant, B.Sc., (N.B. '32), Riverside, N.B. (*S. 1932*)

MILLER, Harry, B.A.Sc., (Tor. '25), Factory Planning Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) Apt. 12, 4155 Cote des Neiges Rd. (*A.M. 1930*)

MILLER, Harry Edward, Asst. Engr., D.P.W., Canada, Box 283, 38 Great George St., Charlottetown, P.E.I. (*H*) 283 Fitzroy St. (*Jr. 1920*) (*A.M. 1925*)

♂MILLER, Henry B., Capt., M.C., B.Sc., (McGill '07), Patricia, Alta. (*S. 1904*) (*Jr. 1912*) (*A.M. 1917*)

MILLER, J. J. H., B.Sc., (McGill '25), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1600 Athlone Rd., Town of Mt. Royal, Que (*S. 1923*) (*A.M. 1931*)

♂MILLER, John Leonard, Major, M.C., Pres. and Gen. Mgr., Herbert Morris Crane and Hoist Co. Ltd., Niagara Falls, Ont. (*H*) Stanley Ave. (*A.M. 1933*)

MILLER, Lindsay, B.Eng., (McGill '33), Cons. Paper Corp. Ltd., Three Rivers, Que. (*H*) 4073 Hampton Ave., Montreal, Que. (*S. 1932*)

♂MILLER, Walter St. John, Lieut., Private Practice, 703 Second St. W. Calgary, Alta. (*H*) 3003–17th St. W. (*A.M. 1921*)

♂MILLER, Warren Cron, Major, B.Sc., (Queen's '17), City Engr. and Treas., St. Thomas, Ont. (*H*) 24 Curtis St. (*S. 1916*) (*Jr. 1920*) (*A.M. 1921*) (*M. 1929*)

♂MILLER, Wilfrid Laverne, B.A.Sc., (Tor. '23), Elec. Engr., Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) 49 Holton Ave. N. (*S. 1921*) (*Jr. 1926*) (*A.M. 1931*)

MILLER, Wm. Frederick, 31 Commercial St., North Bay, Ont. (*S. 1930*)

♂MILLER, Wm. Miles, Major, M.C., (R.M.C., Kingston '12), O.C., Peshawar Dist. Signals, Royal Signals, Peshawar, N.W.F.P., India. (*S. 1910*) (*A.M. 1922*)

MILLIDGE, Edwin R., Div'n. Engr., Mtce., C.N.R., Winnipeg, Man. (*H*) 30 Purcell Ave. (*S. 1902*) (*A.M. 1909*) (*M. 1915*)

MILLIGAN, J. A., Sales Engr., H. E. O. Bull Regd., 437 St. James St. W., Montreal, Que. (*H*) 4482 Marcil Ave., N.D.G. (*S. 1925*)

MILLIKEN, Humphreys, B.S., (M.I.T. '02), Chief Engr., Elec. Dept. Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 280 Markham Rd., Town of Mt. Royal, Que. (*M. 1925*)

MILLS, Arthur McTavish, B.Sc., (Queen's '19), Dist. Engr., Dept. of Northern Development, Box 70, Sudbury, Ont. (*H*) Apt. 1, 295 Cedar St. (*S. 1919*) (*A.M. 1926*)

MILLS, Charles Perkins, B.Sc., (McGill '23), Indust. and Rate Engr., Ebro Irrigation and Power Co. Address: Apartado 491, Plaza de Cataluna 2, Barcelona, Spain. (*H*) Calle Muntaner 514. (*S. 1921*) (*Jr. 1927*) (*A.M. 1933*)

MILLS, Douglas S., MeAdam, N.B. (*S. 1929*)

♂MILLS, Frederick Oldham, Asst. Engr., D.P.W., Canada, Post Office Bldg., New Westminster, B.C. (*H*) 108–6th Ave. (*S. 1906*) (*A.M. 1912*)

MILLS, Thos. S., B.A., B.Sc., (Queen's '11), D.L.S., Asst. Chief Engr., National Parks Br., Dept. Interior, Ottawa, Ont. (*H*) 72 Craig St. (*A.M. 1919*) (*M. 1926*)

♂MILNE, Arthur Hartley, Lieut., B.Sc., (McGill '17), Dir., Dept. of Bldgs., Protestant Bd. of School Commrs., 3460 McTavish St., Montreal, Que. (*H*) 4786 Grosvenor Ave. (*S. 1914*) (*Jr. 1918*) (*A.M. 1920*) (*M. 1928*)

MILNE, Geoffrey Robertson, Asst. Supt., Manseau Shipyards Ltd., Box 175, Sorel, Que. (*S. 1921*)

MILNE, Jas. R. B., Mech. Supt., Price Bros. & Co. Ltd., Kenogami, Que. (*H*) 37 Lapointe St. (*Jr. 1932*)

MILNE, Oswald, Gen. Mgr., Peabody Ltd., 4 Clements Inn, London, W.C.2. (*H*) 43 Woodruff Ave., St. Catharines, Ont. (*S. 1922*) (*Jr. 1926*) (*A.M. 1931*)

MILNE, Winford Gladstone, Gen. Mgr., N. Slater Co., Ltd., Hamilton, Ont. (*H*) 151 Delaware Ave. (*A.M. 1919*) (*M. 1935*)

MILOT, Camille, B.A.Sc., C.E., (Ecole Polytech., Montreal '19), Asst. Chief Engr., D.P.W. and L., Quebec, Que. (*H*) 70 Moncton St. (*S. 1919*) (*Jr. 1920*) (*A.M. 1922*)

MINARD, Guy M., B.Sc., (Queen's '28), Supt. of Tech. Dept., Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*H*) 33 Drury Ave. (*Jr. 1929*)

MISENER, John S., Mech. Refinery Mgr., Acadia Sugar Refining Co., Box 400, Woodside, Dartmouth, N.S. (*M. 1919*)

♂MITCHELL, Chas. Hamilton, Brig.-Gen., C.B., C.M.G., D.S.O., B.A.Sc., C.E., (Tor. '98), LL.D., D.Eng., Dean of the Faculty of Applied Science, University of Toronto, and Cons. Engr., Toronto, Ont. (*H*) 35 N. Sherbourne St., Rosedale, Toronto, Ont. (*S. 1894*) (*A.M. 1898*) (*M. 1902*) (*Past-President*).

♂MITCHELL, Coulson N., Capt., V.C., M.C., B.C.E., (Man. '12), Gen. Supt. of Constrn., Power Corp. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 123 Vivian Ave., Town of Mt. Royal, Que. (*S. 1911* (*A.M. 1917*)

♂MITCHELL, Frank Leslie, Lieut., B.Sc., (McGill '21), Can. International Paper Co., Three Rivers, Que. (*Jr. 1922*) (*A.M. 1930*)

♂MITCHELL, Gordon, Capt., B.A.Sc., 796 Crawford St., Toronto, Ont. (*S. 1914*) (*A.M. 1926*)

MITCHELL, G. B., C.E., (Colorado), Dir. and Gen. Supt., The Atlas Construction Co., Montreal, Que. (*H*) 28 Richelieu Place. (*M. 1913*)

MITCHELL, J. Murray, B.Sc., (McGill '23), Dist. Traffic Supt., The Bell Telephone Co. of Canada, Three Rivers, Que. (*H*) 2427–5th Ave. (*S. 1922*) (*Jr. 1930*) (*A.M. 1935*)

MITCHELL, Jas. Thomson, B.Sc., (Glasgow '14), Commr. of Patents, Fed. Govt., Patent Office, Ottawa, Ont. (*H*) 81 Park Ave. (*A.M. 1916*)

MITCHELL, Lawrence E., B.Sc., (N.S.T.C. '32), Dftsman., Intern. Petroleum Co. Ltd., Talara, Peru, S.A. (*H*) Welchpool, Campobello, N.B. (*S. 1930*)

MITCHELL, Robt. Walter, B.Eng., (McGill '33), Merck & Co. Ltd., Montreal, Que. (*H*) 135 Balfour Ave., Town of Mt. Royal, Que. (*S. 1933*)

♂MITCHELL, R. W., Major, M.C., Chief Engr., Pressure Pipe Co. of Canada, Ltd., 760 Victoria Sq., Montreal, Que. (*H*) 646 Murray Hill, Westmount, Que. (*Jr. 1912*) (*A.M. 1920*)

MITCHELL, Samuel Phillips, Cons. Engr. and Pres., Seaboard Construction Co., 1450 Real Estate Trust Bldg., Philadelphia, Pa. (*H*) 127 Maplewood Ave. (*M. 1912*)

MITCHELL, Wallace M., B.Sc., (McGill '24), Brunner, Mond Canada, Ltd., Amherstburg, Ont. (*H*) Laird Ave. (*S. 1923*) (*A.M. 1930*)

MITCHELL, Wm. Gordon, B.Sc., M.Sc., (McGill '14), Tech. Adviser, Pulp and Paper Research Institute, 3420 University St., Montreal, Que. (*H*) 3 Redpath Place. (*M. 1920*)

MITCHELL, Wm. Reg., B.Sc., (Man. '34), 344 Overdale St., Deer Lodge, Winnipeg, Man. (*S. 1934*)

♂MITCHESON, Septimus, 2226 Hingston Ave., Montreal, Que. (*A.M. 1931*)

MOAKLER, John J., 11 Maxse St., St. John's, Nfld. (*S. 1935*)

MODJESKI, Ralph, C.E., Dr. Engrg., Modjeski, Masters & Case, Inc., Vanderbilt Concourse Bldg., 52 Vanderbilt Ave., New York, N.Y (*H*) 30 Beekman Place (*M.1909*)

MOES, G., Gen. Mgr., Hamilton Sterling Electrical Co. Ltd., 428 Cannon St. E., Hamilton, Ont. (*H*) Aldershot, Ont. (*A.M. 1930*)

MOFFAT, Thomas Stuart, B.Sc., (McGill '27), Supt., Provincial Wood Products Co., Kanes Corner, Saint John, N.B. (*H*) 67 Seely St. (*S. 1925*) (*A.M. 1935*)

MOFFATT, Robert Ray, Asst. Chief Dftsman, Dom. Steel and Coal Corp., Ltd., Sydney, N.S. (*H*) 55 Ankerville St. (*A.M. 1924*)

MOFFATT, Robert W., B.A.Sc., (Tor. '10), Asst. Prof., Dept. of C.E., University of Manitoba, Broadway Ave., Winnipeg, Man. (*H*) 900 Jessie Ave. (*S. 1910*) (*A.M. 1913*)

MOLKE, Eric C., C.E., (Vienna '23), Asst. Engr., E. Gohier, Cons., Engr., 10 St. James St. E., Montreal, Que. (*H*) 12118 Ranger St., Cartierville, Que. (*Jr. 1927*) (*A.M. 1930*)

MOLLARD, J. E., B.Sc., (Sask. '31), Dist. Supt., Sask. Power Comm., Tisdale, Sask. (*H*) Waterous, Sask. (*S. 1931*)

MOLLEUR, Gerald, B.A.Sc., (Ecole Polytech., Montreal '24), Quebec Streams Comm., New Court House, Montreal, Que. (*H*) 105 St. Cyrille St., Quebec, Que. (*S. 1924*) (*A.M. 1932*)

♂MONKMAN, George H. N., Capt., Palliser Hotel, Calgary, Alta. (*S. 1910*) (*Jr. 1914*) (*A.M. 1921*) (*M. 1927*)

G.†MONSARRAT, Chas. N., Lt.-Col., Cons. Engr., Monsarrat & Pratley, 909 Drummond Bldg., Montreal, Que. (*H*) E-70, The Chateau Apts. (*A.M. 1898*) (*M. 1905*)

MONTAGUE, John Russell, C.E. and B.A.Sc., (Tor. '14), Hyd. Engr. of Design, H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 51 Chudleigh Ave. (*A.M. 1918*)

♂MONTAGUE, T. M., Lieut., Belgian C. de G., B.Sc., (McGill '09), Technical Service (Sewer Comm.), City Hall, Montreal, Que. (*A.M. 1914*)

MONTGOMERY, Hugh R., B.Sc., (McGill '29), Res. Engr., The Atlas Construction Co. Ltd., 679 Belmont St., Montreal, Que. (*H*) 2080 Lincoln Ave. (*S. 1928*) (*A.M. 1932*)

♂MONTGOMERY, Samuel Clifford, Lieut., M.C., B.Sc., (McGill '15), Constrn. Office, Cons. Mining and Smelting Co., Trail, B.C. (*S. 1911*) (*Jr. 1920*) (*A.M. 1929*)

MONTGOMERY, Thos., Chief Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 276 North Brock St. (*M. 1922*)

♂MONTIZAMBERT, Harry Bell, Capt., Apt. 7, 1445 Bishop St., Montreal, Que. (*A.M. 1926*)

MONTREUIL, Joseph O., M.A., Chief of Dist. No. 3, Prov. Que. Dept. of Rds., Quebec, Que. (*H*) Everell, Que. (*A.M. 1904*) (*M. 1913*)

†MOODIE, Kenneth, B.Sc., (McGill '95), Combustion Engr., D.P.W. of B.C., Victoria, B.C. (*S. 1895*) (*A.M. 1911*) (*M. 1926*)

MOODIE, Walter Taylor, Gen. Supt., C.N.R., North Bay, Ont. (*H*) 46 Copeland St. (*M. 1918*)

MOON, Clyfforde G., 66 Yates St., St. Catharines, Ont. (*S. 1907*) (*A.M. 1911*)

MOON, George Douglas, B.A.Sc., (Tor. '23), c/o Div. Plant Superv., O.D., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*S. 1921*) (*Jr 1928*) (*A.M. 1934*)

♂MOONEY, Frank M., Jr., B.Sc., (McGill '20), The Croft, Durrington, Salisbury, Wilts., England. (*S. 1914*) (*Jr. 1921*) (*A.M. 1926*)

MOONEY, John P., B.Sc., (N.B. '16), Mgr., Mooney Construction Co., 49 Canterbury St., Saint John, N.B. (*H*) 112 Queen St. (*Jr. 1918*) (*A.M. 1920*)

MOORE, Alex. Glydon, B.Sc., (N.S.T.C. '25), Montreal L.H. & P. Cons., Rm. 319, Power Bldg., Montreal, Que. (*H*) 1450 Crescent St. (*S. 1923*) (*Jr. 1930*) (*A.M. 1935*)

♂MOORE, Chas. M., B.Sc., (Queen's '19), Medicine Hat, Alta. (*S. 1919*) (*Jr. 1920*) (*A.M. 1924*)

G.MOORE, Ernest Vivian, B.Sc., (McGill '00), Sales Mgr., Ont. Dock and Forwarding Co., Rm. 608, Sterling Tower, 372 Bay St., Toronto, Ont. (*H*) 121 Chaplin Cres. (*A.M. 1903*) (*M. 1905*)

MOORE, Geo. Albert, B.Eng., (McGill '33), Baldwins, Montreal Ltd., 1416 Royal Bank Bldg., Montreal, Que. (*H*) 366 Wood Ave. (*S. 1931*)

MOORE, Henry Alex., B.A., Cons. Engr., P.O. Box 686, Trenton, Ont. (*M. 1907*)

MOORE, Herbert H., (Tor. '02), A.L.S., D.L.S., Private Practice, 427 Riverdale Ave., Calgary, Alta. (*S. 1904*) (*A.M. 1909*)

MOORE, Lewis N., B.Sc., (McGill '27), Asst. Div. Equipment Engr., E.O.D., The Bell Telephone Co. of Canada, Ottawa, Ont. (*H*) 312 Fifth Ave. (*S. 1927*) (*A.M. 1932*)

MOORE, Robt. H., B.Sc., (Man. '34), Hudson's Bay M. & S. Co. Ltd., Flin Flon, Man. (*H*) 240 Balfour Ave., Winnipeg, Man. (*S. 1930*)

♂MOORE, Thomas John McLuckie, Dom. Water Power and Hydrometric Bureau, Dept. Interior, Box 235, North Bay, Ont. (*A.M. 1922*)

MOORE, Wm. Herbert, B.Sc., (McGill '27), (M.Eng., '32), Can. Marconi Co. Ltd., Montreal, Que. (*H*) 460 Grosvenor Ave., Westmount, Que. (*S. 1925*) (*A.M. 1934*)

MOORE, Wm. J., (Tor. '06), O.L.S., County Engr., and Rd. Supt., Renfrew County, Box 1048, Pembroke, Ont. (*S. 1907*) (*A.M. 1910*)

MOREY, Harold Arthur, B.Sc., (Dartmouth '08), Mgr., N.S. Wood Pulp and Paper Co. Ltd., Charleston, Queen's Co., N.S. (*A.M. 1922*)

MORGAN, A. Hedley, Vice Pres. and Wks. Mgr., E. Leonard & Sons, Ltd., London, Ont. (*H*) 294 Hyman St. (*M. 1922*)

MORGAN, Jas. Clarence, B.A.Sc., (Tor. '30), (M.A., '31), 50 Rose Ave., Toronto 5, Ont. (*S. 1929*) (*Jr. 1931*)

MORGAN, N. L., B.Sc., (McGill '14), Cable Research Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 107 Kindersley Rd. So., Town of Mount Royal, Que. (*A.M. 1919*)

♂MORGAN, Philip Harold, Capt., Gen. Constrn. Supt., Beauharnois L. H. and P. Co., P.O. Box 50, Beauharnois, Que. (*A.M. 1934*)

MORHAM, Robert, Cole Snow Plow Co., 631 Confederation Life Bldg., Toronto, Ont. (*H*) 1003 Mt. Pleasant Rd. (*A.M. 1920*)

MORITZ, Chas. J. H., B.Sc., (Mich. '97), Vice-Pres., Aluminium Ltd. Address: Aluminum Co. of America, Niagara Falls, N.Y. (*A.M. 1901*) (*M. 1909*)

MORKILL, John Thomas, Private Practice, 74 Court St., Sherbrooke, Que. (*M. 1888*) (*Life Member*)

MORLEY, Edward H., R.R. 2, Rose Cottage, Yarmouth, N.S. (*M. 1910*) (*Life Member*)

MORRIS, Harold K., B.Eng., (McGill '35), 2063 Stanley St., Montreal, Que. (*S. 1935*)

†MORRIS, James L., D.Eng., '27, C.E., (Tor. '85), D.Eng., '27, O.L.S., Inspector of Surveys, Dept. of Lands and Forests, Parliament Bldgs., Toronto, Ont. (*H*) Apt. 303, 200 St. Clair Ave. W. (*A.M. 1887*) (*M. 1904*) (*Life Member*)

MORRIS, John William, B.A.Sc., (McGill '94), Gen. Mgr., Newfoundland Light and Power Co., P.O. Box 823, St. John's, Nfld. (*M. 1920*)

MORRIS, S. Rupert, Memorial University College, St. John's, Nfld. (*H*) Trinity Bay, Nfld. (*S. 1935*)

♂MORRISEY, Henry Fairweather, Lieut., M.Sc., (N.B. '15), Dist. Engr., Marine Dept., Saint John, N.B. (*H*) 65 Hazen St. (*Jr. 1913*) (*A.M. 1922*)

♂MORRISEY, T. Sydney, Lt.-Col., D.S.O., (R.M.C. '10), Owner, The Specialty Machinery Co., 324 Coristine Bldg., Montreal, Que. (*H*) 3275 Cedar Ave. (*S. 1919*) (*Jr. 1913*) (*A.M. 1924*) (*M. 1931*)

MORRISON, C. F., B.E., (Sask. '25), M.Sc., (McGill '27), Lecturer in C.E., Univ. of Toronto, Toronto, Ont. (*H*) 6 Lowther Ave. (*Jr. 1929*)

MORRISON, C. W., B.Sc., (McGill '31), R.C.A.F. Station, Ottawa, Ont. (*S. 1931*)

MORRISON, George, (C.G.I. '97), Commonwealth Electric Corp. Ltd., P.O. Box 308, Welland, Ont. (*A.M. 1924*) (*M. 1926*)

MORRISON, G. H., B.Sc., (N.S.T.C. '25), Kimberley, B.C. (*Jr. 1930*)

MORRISON, J. A., B.A.Sc., (Tor. '28), Sales Engr., Consumers Gas Co., 124 Richmond St. W., Toronto, Ont. Address: West End Y.M.C.A., Toronto, Ont. (*S. 1928*)

♂MORRISON, James R., Lieut., Field Engr., Dom. Coal Co., Glace Bay, N.S. (*H*) 28 Lorway Ave., Sydney, N.S. (*S. 1905*) (*A.M. 1914*)

MORRISON, J. W., B.Sc., (Dalhousie and N.S.T.C.), Cons. Mining Engr., 111 Main St., Haileybury, Ont. (*M. 1919*)

MORRISON, Thos. Jack, B.Sc., (McGill '30), 4714 Western Ave., Westmount, Que. (*S. 1930*)

MORRISON, William P., Sr. Asst. Engr., P.W.D., Canada, P.O. Box 225, Halifax, N.S. (*A.M. 1898*) (*M. 1907*)

♂MORRISON, Wm. Stuart Estleigh, Lieut.-Cmdr., Canada Creosoting Co., Sudbury, Ont. Address: P.O. Box 1, Sudbury, Ont. (*A.M. 1927*)

MORRISSETTE, J. N. E. Romeo, Cons. Engr., Box 219, Cap de la Madeleine, Que. (*S. 1908*) (*Jr. 1912*) (*A.M. 1919*)

MORROW, Harold A., (R.M.C., Kingston), Pres., Morrow & Beatty, Ltd., Box 782, Peterborough, Ont. (*S. 1888*) (*A.M. 1894*) (*M. 1902*)

MORSE, John, B.Sc., (Chalmers '06), Gen. Supt., Shawinigan Water and Power Co., 611 Power Bldg., Montreal, Que. (*H*) 3437 Harvard Ave (*A.M. 1916*) (*M. 1926*)

G.†MORSSEN, Chas. M., C.E., (Ecole Nat. des Ponts et Chaussées), Cons. Engr., Rm. 24, 758 Victoria Sq., Montreal, Que. (*A.M. 1909*) (*M. 1914*)

MORTON, Philip S. A., B.A.Sc., (Tor. '28), Can. Gen. Elec. Co. Ltd., Montreal, Que. (*H*) 3670 Lorne Cres. (*Jr. 1931*)

MOSS, Charles S., Deer Park, B.C. (*A.M. 1902*)

G.†MOTLEY, Phillips B., Engr. of Bridges, C.P.R., Montreal, Que. (*H*) 2 Sunnyside Ave., Westmount, Que. (*A.M. 1898*) (*M. 1905*)

♂MOTT, Harold Edgar, Capt., B.Sc., (McGill '22), Pres. and Gen. Mgr., H. E. Mott & Co. Ltd., Brantford, Ont. (*H*) 63 Chestnut Ave. (*S. 1919*) (*A.M. 1926*) (*M. 1935*)

MOULTON, Arthur Garland, Vice-Pres., Thompson-Starrett Co. Inc., 444 Madison Ave., New York, N.Y. (*H*) 5432 E. View Park, Chicago, Ill. (*M. 1923*)

♂MOUNT, Wilfred Rowland, Major, M.C., Asst. Engr., City of Edmonton, Civic Block, Edmonton, Alta. (*H*) 9801–110th St. (*A.M. 1921*) (*M. 1934*)

♂MOUNTFORD, Geo. Collenge, Mech. Supervisor, Ont. Plant, H.E.P.C. of Ont., Niagara Falls, Ont. Address: Chippawa, Ont. (*A.M. 1926*)

MOYER, John C., B.Sc., (Queen's '12), Asst. Supt'g. Engr., Dept. of Railways and Canals, Welland Ship Canal, St. Catharines, Ont. (*H*) 38 Academy St. (*S. 1912*) (*A.M. 1916*)

♂MOXON, Geo. Burnham, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 210 Lake Shore Rd., Pointe Claire, Que. (*A.M. 1934*).

♂†MUCKLESTON, Hugh B., Major, (R.M.C., Kingston), Cons. Engr., 901 Rogers Bldg., Vancouver, B.C. (*H*) 1243 Thurlow St. (*M. 1907*)

†MUDGE, Arthur Langley, B.A.Sc., (McGill '94), Cons. Elec. Engr., 21 Crescent Rd., Toronto, Ont. (*S. 1894*) (*A.M. 1899*) (*M. 1925*)

♂MUDGE, Reginald, Capt., B.Sc., (McGill '06), Asst. Engr., C.P.R., Rm. 401, Windsor Station, Montreal, Que. (*H*) 3610 Durocher St. (*S. 1906*) (*A.M. 1913*)

MUELLER, E. K., B.A.Sc., (Tor. '24), Dist. Engr., C.N.D., The Bell Telephone Co. of Canada, Toronto, Ont. (*H*) 76 Robina Ave. (*S. 1921*) (*A.M. 1930*)

MUELLER, Victor Leo, Engr., Can. and General Finance Co., Ltd., 25 King St. W., Toronto, Ont. (*H*) 49 Radford Ave. (*Jr. 1921*)

MUGAAS, Henrik, Lamaque Gold Mines, Ltd., Val d'Or, Via Amos, Que. (*A.M. 1932*)

MUIR, Clarke Bower, B.Sc., (N.S.T.C. '31), Supt., Wire Dept., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 323 Dalhousie St. (*S. 1931*)

MUIR, Wm. Gordon, B.Sc., (N.S.T.C. '31), Sales Engr., Alexander Murray Co. Ltd., Halifax, N.S. (*H*) 28 Victoria Rd. (*Jr. 1933*)

♂MUIRHEAD, Stuart R., B.A.Sc., (Tor. '24), Engr., Dept. of Telephones, Sask., Regina, Sask. (*H*) 371 Leopold Crescent. (*S. 1920*) (*Jr. 1924*) (*A.M. 1930*)

MULLEN, Thos. J., Jr., B.Eng., (McGill '34), Sales Engr., B. F. Sturtevant Co., 708 Mills Bldg., 17th and Penna. Ave., Washington, D.C. (*S. 1933*)

MULLER, P. P., B.Sc., (McGill '29), Swaine & Adeney Ltd., 185 Piccadilly, London, W.1. (*H*) Naylor House, Larknield, Albion Rd., London, S.W.8. (*S. 1929*)

MULLIGAN, H. I., B.Sc., (McGill '26), N.B. Electric Power Comm., Newcastle Creek, N.B. (*S. 1926*) (*A.M. 1935*)

♂†MULOCK, Redford H., C.B.E., D.S.O., B.Sc., 3484 Marlowe Ave., Montreal, Que. (*S. 1905*) (*A.M. 1912*)

MUMFORD, Wm. Vaus, Engr., City Arch't's. Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 83 Glenmore Rd. (*A.M. 1929*)

♂MUNFORD, Thomas Albert Sprake, Asst. Engr., Bruce Divn., C.P.R., Toronto, Ont. (*H*) 244 Westmount Ave. (*A.M. 1921*)

MUNN, Thos. H., B.Sc., (B.C. '31), Island Mountain Mines Co. Ltd., Wells, B.C. (*H*) 3793–23rd Ave. W., Vancouver, B.C. (*S. 1930*)

♂MUNRO, Alan H., Lieut., B.A.Sc., (Tor. '11), 352 Brock St., Peterborough, Ont. (*S. 1911*) (*A.M. 1920*)

MUNRO, David J., B.Sc., (McGill '23), Equipment Engr., Montreal Tramways Co., Youville Shops, Montreal, Que. (*H*) 30 Dobie Ave., Town of Mt. Royal, Que. (*S. 1921*) (*Jr. 1927*)

♂MUNRO, W. Hamilton, Major, (Tor. '04), Gen. Mgr., Ottawa Electric Co. and Ottawa Gas Co., 300 Cooper St., Ottawa, Ont. (*A.M. 1908*) (*M. 1920*)

MUNSON, A. H., (Tor. '09), Chief Inspr. and Indust. Engr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 39 Westminster Ave. S. (*S. 1911*) (*A.M. 1916*)

♂MUNTZ, E. P., Capt., B.A.Sc., (Tor. '14), Pres., E. P. Muntz, Ltd., Box 357, Dundas, Ont. (*H*) 292 Bay St. S., Hamilton, Ont. (*S. 1913*) (*A.M. 1919*) (*M. 1927*)

MURDOCH, Gilbert Gray, Private Practice, 74 Carmarthen St., Saint John, N.B. (*H*) 272 Douglas Ave. (*S. 1905*) (*A.M. 1911*) (*M. 1919*)

MURDOCK, Charles Russell, B.A.Sc., (Tor. '11), Town Engr. and Townsite Mgr., Spruce Falls Power and Paper Co., Box 319, Kapuskasing, Ont. (*A.M. 1912*)

MURPHY, Alexander Gordon S., B.Sc., (McGill '22), c/o D. W. McLachlan, Dept. of Railways and Canals, Ottawa, Ont. (*Jr. 1922*) (*A.M. 1931*)

MURPHY, Emmett Patrick, Divn. Engr., Section 8, Welland Ship Canal, Dept. Railways and Canals, Port Colborne, Ont. (*S. 1909*) (*A.M. 1915*)

MURPHY, John J., 201 O'Connor St., Ottawa, Ont. (*A.M. 1890*)

†MURPHY, John, Elec. Engr., Rly. Comm., and Rlys. and Canals Dept.; Acting Supt'g. Engr., Rideau Canal, P.O. Box 323, Ottawa, Ont. (*H*) 606 Somerset St. W. (*A.M. 1904*) (*M. 1913*)

MURPHY, Stephen John, B.Sc., (McGill '13), National Research Council, Ottawa, Ont. (*H*) 163 Holmwood Ave., Ottawa, Ont. (*A.M. 1922*)

MURPHY, Thos. R H., R.F.D. No. 1, Ridgefield, Conn. (*A.M. 1917*)

MURRAY, Archibald (*q*), B.A., (Acadia '94), Asst. Engr., Dept. of Railways and Canals, 317 West Block, Ottawa, Ont. (*H*) 406 Aylmer Apts. (*S. 1904*) (*A.M. 1914*)

♂MURRAY, Robert Hutchison, Lt.-Col., Dir., Sanitation Divn., Dept. Public Health, Sask., Regina, Sask. (*H*) 3067 Angus St. (*A.M. 1911*)

MURRAY, Robt. Leslie, Vernon, P.E.I. (*S. 1931*)

MURRAY, Robt. Roy, B.Sc., (N.S.T.C. '14), Dir., Wm. Stairs Son & Morrow, Water St., Halifax, N.S. (*H*) 87 Cambridge St. (*A.M. 1920*) (*Sec.-Treas., Halifax Br., E.I.C.*)

MURRAY, Victor Stuart, B.Sc., (Queen's '28), Strl. Engr., Bridge Dept., Dept. of Highways, Parliament Bldgs., Toronto, Ont. (*S. 1928*)

MURRAY, Walter M., B.Sc., (Man. '32), Flying Officer, Officers' Mess, R.C.A.F. Station, Ottawa, Ont. (*S. 1929*)

MURRAY, William Alexander, Rm. 623, Transportation Bldg., Montreal, Que. (*H*) Georgeville, Que. (*A.M. 1898*)

MURRAY, Wm. MacG., B.Eng., (McGill '32), M.Sc., (M.I.T. '34), Mass. Institute of Technology, Cambridge, Mass. (*H*) Georgeville, Que. (*S 1932*)

MURRIN, Wm. Geo., Pres., B.C. Electric Railway Co., Ltd.. Vancouver. B C. (*H*) 2106 W. Marine Dr. (*M. 1924*)

♂MUSGRAVE, Wm. Burnthorne, B.Sc., (Queen's '20), 1181 McGlashan Cres., Niagara Falls, Ont. (*A.M. 1922*)

MUSSEN, Guy A., B.Eng., (McGill '35), 2076 Sherbrooke St. W., Montreal, Que. (*S. 1935*)

MUSSEN, William H. C., Pres., Mussen's Ltd., 40 Phillips Place Bldg., Montreal, Que. (*H*) Flagpole Point, Dorval, Que. (*Affil. 1903*)

NAISH, S. Gordon, B.Sc., (Durham '23), Eastern Dist. Mgr., Peacock Bros. Ltd., Post Bldg., Sydney, N.S. (*H*) 100 Whitney Ave. (*Jr. 1927*) (*A.M. 1934*)

♂†NAISH, T. E., Major, P.O. Box 167, Penticton, Lake Okanagan, B.C. (*M. 1904*) (*Life Member*)

NANCARROW, Gilbert Owen, 55 Clarence Rd., Torpoint, Cornwall, England. (*AM. 1933*)

NANTEL, Maurice, B.A.Sc., (Ecole Polytech., Montreal '33), Montreal Water Board, 3161 Joseph St., Verdun, Que. (*H*) 3695 St. Catherine St. E., Montreal, Que. (*S. 1932*)

NAPIER, Geo. Paxton, Deputy Minister and Chief Engr., Dept. of Rlys.; Acting Deputy Minister and Asst. Chief Engr. of P.W. of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 918 Cook St. (*M. 1920*)

♂NASH, Jas. Cunniff, B.A.Sc., (Tor. '12), Dftsman., Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) 147 Mountain Park Ave. (*A.M. 1922*)

NATION, Frederick Spencer, B.Sc., (McGill '30), 222 Rosemary Rd., Toronto, Ont. (*S. 1930*)

NATTRESS, David Irving, B.A.Sc., (Tor. '23), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 44 Chicora Ave. (*S. 1920*) (*Jr. 1925*)

NEAR, W. Percival, B.A., B.A.Sc., (Tor.), Cons. Engr., 39 Alexandra Blvd., Toronto, Ont. (*A.M. 1909*) (*M. 1920*)

NEELANDS, Ernest Wesley, B.A.Sc., (Tor. '07), O.L.S., Field Engr. on Constrn., Falconbridge Nickel Mines Ltd., Falconbridge, Ont. (*H*) 141 Strathmore Blvd., Toronto, Ont. (*A.M. 1912*)

NEIL, J. Stuart, B.Sc., (Alta. '30), Inspr., Gas Fixtures Appliances, Can. Western Natural Gas, L., H. & P. Co. Ltd., Calgary, Alta. (*H*) Ste. 2, Sills Apts., 14th Ave. W. (*Jr. 1932*)

♂†NELLES, Douglas H., Major, D.L.S., Engrg. Service, Can. National Parks, Dept. Inter., Ottawa, Ont. (*H*) 223 McLeod St. (*S. 1904*) (*A.M. 1906*) (*M. 1915*)

NELSON, Edward, Engr. i/c., Northwestern Utilities Ltd., 10124-104th St., Edmonton, Alta. (*H*) 11003-84th Ave. (*A.M. 1935*)

NELSON, H., 920 Jessie Ave., Winnipeg, Man. (*S. 1930*)

NENNIGER, E., Arthur Surveyer & Co., 1003 Dom. Square Bldg., Montreal, Que. (*H*) 6154 Notre Dame de Grace Ave. (*Jr. 1926*) (*A.M. 1928*)

NESBITT, A. Deane, B.Eng., (McGill '33), 41 Forden Ave., Westmount, Que. (*S. 1933*)

NESBITT, Michael Cullum, R.M.D. No. 4, Victoria, B.C. (*S. 1928*)

NESHAM, Lionel Charles, B.Sc., (McGill '16), Rm. 413, C.P.R., Windsor Sta., Montreal, Que. (*H*) 2134 Prudhomme Ave. (*Jr. 1919*) (*A.M. 1924*)

NEVITT, Irving H., B.A.Sc., (Tor. '04), 1st. Asst. Engr., City of Toronto, 1091 Eastern Ave., Toronto, Ont. (*H*) 8 Glen Edythe Drive. (*A.M. 1910*) (*M. 1919*)

†NEWELL, Fred, Asst. Chief Engr., Dom. Bridge Co. Ltd., Box 4016, Montreal, Que. (*H*) 4052 Wilson Ave. (*A.M. 1916*) (*M. 1923*)

NEWELL, Joseph Pettus, C.E., (M.I.T.), Cons. Civil Engr., Newell, Carter & Walsh, Rm. 822, 319 S.W. Washington St., Portland, Oregon. (*H*) 3290 S.E. Harrison St. (*M. 1921*)

NEWHALL, Vivian A., B.A.Sc., (Tor.), Sales Engr., Bell & Morris, 572-8th Ave. W., Calgary, Alta. (*H*) 2918 Champlain St. (*A.M. 1918*)

NEWILL, Geo. Ernest, Cons. Engr., 1178 Phillips Place, Montreal, Que. (*H*) 183 Connaught Ave. (*M. 1920*)

NEWMAN, John James, O.L.S., Sr. Partner, Newman & Armstrong, 301 Davis Bldg., Windsor, Ont. (*H*) 209 Campbell Ave. (*A.M. 1919*) (*M. 1920*)

NEWMAN, Phillip Marshall, Address unknown. (*S. 1933*)

NEWMAN, Wm. Arthur, B.Sc., (Queen's '11), Chief Mech. Engr., C.P.R. Co., Rm. 1000, Windsor Sta., Montreal, Que. (*H*) 488 Mount Pleasant Ave., Westmount, Que. (*M. 1935*)

NEWMAN, Wm. Cyril, B.Sc., (Alberta '33), Hillmond, Sask. (*S. 1933*)

♂NEWTON, James Boustead, Capt., c/o Royal Bank of Can., 6 Lothbury, London, E.C.2. (*A.M. 1921*)

NEWTON, Samuel R., Chief Engr., Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que. (*H*) 155 Victoria St. (*S. 1902*) (*A.M. 1913*)

NICHOLS, David Andrew, B.Sc., (Queen's '11), M.A., (Columbia '23), Geological Survey, Dept. of Mines, Canada, Victoria Memorial Museum, Ottawa, Ont. (*H*) 29 Argyle Ave. (*M. 1926*)

NICHOLS, Judson Timmis, B.Eng., (McGill '34), Hudson Bay Mining and Smelting Co., Staff House, Flin Flon, Man. (*H*) 81 Chesterfield Ave., Westmount, Que. (*S. 1931*)

NICHOLSON, Edward, Asst. Engr., C.N.R., Central Region, Toronto, Ont. (*H*) 49 Garden Ave. (*A.M. 1920*)

NICHOLSON, Gunnar W. E., (Chalmers '16), Southern Kraft Corp., Moss Point, Miss., U.S.A. (*A.M. 1926*)

NICHOLSON, Robert Morley, B.Sc., (Queen's '33), Dept. of Highways, Chatham, Ont. (*S. 1933*)

NICHOLSON, Thos. Herbert, Pres., T. H. Nicholson Ltd., 1440 St. Catherine St. W., Montreal, Que. (*H*) 1475 Mansfield St. (*A.M. 1922*)

NICKERSON, Allan Douglas, B.Sc., (N.S.T.C. '29), Transm. Engr., Maritime Telegraph and Telephone Co., Halifax, N.S. (*H*) 38 Walnut St. (*S. 1929*) (*A.M. 1934*)

♂NICKLIN, Harold Storey, B.A.Sc., (Tor. '15), City Engr., City Hall, Guelph, Ont. (*H*) 114 Suffolk St. (*A.M. 1920*)

NICOLAISEN, J. Z., B.Sc., (Durham '29), Villa Egemaes, Espergaerde, Denmark. (*S. 1930*) (*A.M. 1935*)

NICOLLS, Jasper H. H., B.Sc., (McGill '08), M.Sc., Chemist, Supervising Solid Fuels Lab., Fuel Research Labs., Dept. Mines, 562 Booth St., Ottawa, Ont. (*H*) 2 Sweetland Ave. (*A.M. 1927*)

NIX, Chas. E., B.Sc., (Alta. '31), 987 Laviolette Blvd., Three Rivers, Que. (*H*) 10219-115th St., Edmonton, Alta. (*S. 1929*)

NIXON, Richard Lewis, B.Sc., (N.S.T.C.), M.Sc., (King's, Halifax '23), Bursar, King's College, Halifax, N.S. (*A.M. 1919*)

NOONAN, Wm. Hysanth, B.Sc., (N.S.T.C. '13), C.E., 126 Roy Bldg., Halifax, N.S. (*H*) 30 Young Ave. (*S. 1913*) (*A.M. 1923*)

NORLEY, Harry Charles, Metallurgist and Service Engr., Can. Atlas Steel Ltd., Welland, Ont. (*H*) 551 Reid St., Peterborough, Ont. (*Affil. 1920*)

NORMAN, Douglas, B.Sc., (Man. '26), Transformer Engr., Can. Gen. Elec. Co. Ltd., 1025 Lansdowne Ave., Toronto, Ont. (*H*) 300 The Kingsway. (*S. 1926*) (*Jr. 1931*)

NORMANDIN, A. B., B.A.Sc., (Ecole Polytech., Montreal), Q.L.S., Asst. Chief Engr., Hydraulic Service, Dept. of Lands and Forests, Rm. 173, Parliament Bldgs., Quebec, Que. (*H*) 164 Fraser St. (*S. 1907*) (*A.M. 1912*) (*M. 1933*) (*Vice-President, E.I.C.*)

♂NORRIS, Chas. A., B.A.Sc., (Tor. '23), Executive, G. R. Locker Co., 1467 Mansfield St., Montreal, Que. (*H*) 4128 Marcil Ave. (*S. 1919*) (*Jr. 1925*) (*A.M. 1926*)

NORRIS, Jas. H., B.Sc.Me., (McGill '12), Man'g. Dir., Wilder-Norris Ltd., 1465 Bleury St., Montreal, Que. (*H*) 47 Stirling Ave. (*S. 1909*) (*Jr. 1915*) (*A.M. 1919*)

NORRISH, Bernard Esterbrook, M.Sc., (Queen's '10), Man'g. Dir., Associated Screen News Ltd., 5271 Western Ave., Montreal, Que. (*H*) 4180 Harvard Ave. (*A.M. 1912*)

NORRISH, Wilbert Henry, B.Sc., (Queen's '12), D.L.S., O.L.S., A.L.S., Dept. of Mines, Motor Bldg., 238 Sparks St., Ottawa, Ont. (*H*) 326 Clemow Ave. (*S. 1912*) (*Jr. 1917*) (*A.M. 1920*)

NORTH, J. Terry, Jr., B.A.Sc., (B.C. '27), Can. Marconi Co., Montreal, Que. (*H*) 1110 Graham Blvd., Town of Mt. Royal, Que. (*S. 1926*)

♂NORTHEY, Robt. Kirkpatrick, Capt., B.A.Sc., (Tor. '12), Sec.-Treas., The Telfer Paper Box Co., Ltd., 14 Duncan St., Toronto, Ont. (*H*) 179 Lyndhurst Ave. (*A.M. 1920*)

♂NORWICH, Harry Ben., B.A.Sc., (Tor. '19), Div. Engr., Ontario Divn., McColl-Frontenac Oil Co., Ltd., 114 Don Esplanade, Toronto, Ont. (*H*) 36 Humber Trail. (*S. 1919*) (*A.M. 1925*)

NOTMAN, Jas. Geoffrey, B.Sc., (McGill '22), Mgr. of Mfg., Dom. Engineering Co., Ltd., Lachine, Que. (*H*) 4655 Roslyn Ave., Westmount, Que. (*S. 1920*) (*A.M. 1930*)

NOURSE, Arthur E., B.A.Sc., (Tor. '08), Asst. Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 33 Gormley Ave. (*S. 1907*) (*A.M. 1914*)

NOURSE, H. C., B.Sc., (Queen's '14), Engr. of Motor Vehicles and Constrn. Apparatus Engr., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 2096 Vendome Ave. (*A.M. 1919*)

NOWLAN, Brete Cassius, B.Sc., (Iowa '00), Telephone Sales Mgr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 5510 Queen Mary Rd. (*A.M. 1921*)

NOYES, Donald F., B.S., (Clarkson), 824 Henley Place, Charlotte, N.C., U.S.A. (*M. 1927*)

♂NUTTER, Jack Caswell, Lieut., B.Sc., (McGill '21), Prod. Mgr., Gair Co. of Can. Ltd., 2 Seigneurs St., Montreal, Que. (*H*) 303 Grosvenor Ave., Westmount, Que. (*S. 1921*) (*Jr. 1926*) (*A.M. 1929*)

♂OAKS, Harold Anthony, Flt.-Cmdr., B.A.Sc., (Tor. '22), Pres. and Gen. Mgr., Oaks Airways, Ltd., Sioux Lookout, Ont. (*S. 1920*) (*Jr. 1926*) (*A.M. 1930*)

♂OATLEY, Henry Bigelow, Lieut., B.S., (Vermont '00), Vice-Pres., The Superheater Co., 60 East 42nd St., New York, N.Y. (*H*) 33 Arleigh Rd., Kensington, Great Neck, L.I., N.Y. (*M. 1921*)

O'BRIEN, Frederick Gordon, B.Sc., (N.S.T.C. '23), Radio Station "CJCB," Whitney Pier P.O., Sydney, N.S. (*A.M. 1932*)

♂O'CONNOR, Garrett Daunt, Lieut., B.Sc., (Queen's '21), Military Camp, Valcartier, Que. (*H*) R.R. 3, Loretteville, Que. (*Jr. 1921*) (*A.M. 1923*)

O'DAY, Martin F., B.Sc., (Man. '26), Shell Oil Co. of Can. Ltd., Montreal East, Que. (*H*) 217 St. Jean Baptiste, Pointe-aux-Trembles, Que. (*S. 1924*) (*A.M. 1931*)

ODDLAFSON, E. W., B.Sc., (Man. '30), H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 9 Albany Ave. (*S. 1928*)

O'DONNELL, John Gerard, B.Sc., (McGill '16), Mtce. Engr., Dept. P.W. and L., Parliament Bldgs., Quebec, Que. (*H*) 48 Couillard St. (*Jr. 1916*) (*A.M. 1921*)

OGILVIE, Noel John, D.L.S., H.B.M. Intern. Boundary Commr.; Director, Geodetic Survey of Canada, Dept. Inter., Ottawa, Ont. (*H*) 96 Carling Ave. (*M. 1916*)

OGILVIE, Wm. M., B.Sc., Fort St. James, Cariboo, B.C. (*H*) 55 Park Ave., Ottawa, Ont. (*S. 1895*) (*A.M. 1911*)

OGILVY, Jas. A., B.Sc., (McGill '30), 3429 Peel St., Montreal, Que. (*S. 1926*) (*A.M. 1935*)

OGILVY, Robert F., B.Sc., (McGill '25), M.Eng., (McGill '32), 3429 Peel St., Montreal, Que. (*S. 1922*) (*A.M. 1932*)

O'HALLORAN, James Sc., (McGill '21), Plant Engr., Anglo-Can. Pulp and Paper Mills, Ltd., Quebec, Que. (*H*) 26 Learmonth Ave. (*S. 1919*) (*Jr. 1922*) (*A.M. 1934*)

♂OLDHAM, Walter Frederick, B.Sc., (Manchester '06), Assessor, Assessment Dept., City of Winnipeg, City Hall, Winnipeg, Man. (*H*) 205 Maplewood Ave. (*A.M. 1919*)

♂O'LEARY, H. Gordon, B.A.Sc., (Tor. '04), Supt., C.N.R., Fort William, Ont. (*H*) 517 Lucie Court. (*S. 1906*) (*A.M. 1910*)

OLESKEVICH, Veni, B.Eng., (McGill '32), Smooth Rock Falls, Ont. (*S. 1930*)

♂OLIVER, Cuthbert J., B.Sc., (McGill '23), Overhead Distribution Engr., Rio de Janeiro Tramway Light and Power Co., Ltd., Caixo de Correo 571, Rio de Janeiro, Brazil, S.A. (*S. 1919*) (*Jr. 1924*) (*A.M. 1931*)

OLIVER, Ernest Warren, B.A.Sc., C.E., (Tor. '04), Dir. of Service and Research, St. Louis Southwestern Rly., Cotton Belt Bldg., St. Louis, Mo., U.S.A. (*M. 1912*)

OLIVER, Stuart Erskine, B.Sc., C.E., (McGill '11), Q.L.S., Land Surveys Dept., C.N.R., Montreal, Que. (*H*) 577 Roslyn Ave. (*S. 1909*) (*Jr. 1913*) (*A.M. 1919*)

OLIVER, Stuart Stirling, 1 St. Stanislas St., Quebec, Que. (*A.M. 1887*) (*Life Member*)

OLSEN, Aleksander, Supt., E. G. M. Cape & Co., New Birks Bldg., Montreal, Que. (*H*) 5276 Saranac Ave. (*A.M. 1934*)

OLSON, Haldor Theodore, Operator, Churchill River Pr. Co. Ltd., Island Falls, Sask., Via Flin Flon, Man. (*Affil. 1934*)

♂OMMANNEY, G. G., Major, Director, Dept. of Development, C.P.R., Windsor Sta., Montreal, Que. (*H*) Apt. 7, 2177 Lincoln Ave. (*M. 1921*)

♂OPENSHAW, John E., Lieut., B.Sc., (McGill), B.Eng., (Liverpool), Pres., Openshaw & Bennet, Ltd., 420 Lagauchetiere St. W., Montreal, Que. (*H*) 88 Church Hill Ave., Westmount, Que. (*S. 1909*) (*A.M. 1913*)

ORANGE, Frank Angel, B.Sc., (Queen's '27), International Nickel Co., Copper Cliff, Ont. (*H*) 188 Station St., Sudbury, Ont. (*S. 1927*) (*A.M. 1934*)

ORD, L. R., D.L.S., O.L.S., 10 Rosedale Rd., Toronto, Ont. (*A.M. 1887*) (*M. 1897*) (*Life Member*)

O'REILLY, Francis Joseph, B.C.L.S., Mgr., Cross & Co., Belmont House, Victoria, B.C. (*H*) 2616 Pleasant St. (*M. 1915*)

O'ROURKE, John Francis, Pres. and Cons. Engr., O'Rourke Engrg. Constrn. Co., 17 Battery Place, New York, N.Y. (*H*) 383 Park Ave. (*M. 1887*) (*Life Member*)

ORR, Fred'k. Ormond, Cons. Engr., 833 Hastings St. W., Vancouver, B.C. (*H*) 3235 Point Grey Rd. (*A.M. 1920*)

ORR, Walter Alyn, B.Sc., (Alta. '32), R.C.A.F. Station, Trenton, Ont. (*H*) Wetaskiwin, Alta. (*S. 1932*)

ORROCK, John Wilson, Engr. of Bldgs., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 62 Arlington Ave., Westmount, Que. (*A.M. 1896*) (*M. 1907*)

ORWELL, A. E., (R.M.C., Kingston '28), B.Sc., (Queen's '30), Northern Electric Co., Ltd., Montreal, Que. (*H*) Apt. 6, 3181 Maplewood Ave. (*S. 1928*)

OS, Hartvik, (Grad. Trond. '23), 423 Rita St., Port Arthur, Ont. (*Jr. 1925*) (*A.M. 1931*)

OSBORNE, Gurdon Hoard, B.S., (Mich. State), Gen. Mgr. and Dir., The Ventilating and Blow Pipe Co. Ltd., 714 St. Maurice St., Montreal, Que. (*H*) 836 Pratt Ave., Outremont, Que. (*A.M. 1921*)

OSLER, Chas. Ernest, Apt. 8, 4516 Girouard Ave., Montreal, Que. (*S. 1906*) (*Jr. 1912*) (*A.M. 1922*)

♂O'SULLIVAN, John Joseph, Staff Captain, J. J. O'Sullivan, Inc., 103 Park Ave., New York, N.Y. (*M. 1921*)

O'SULLIVAN, Louis Leo., B.Sc., (McGill '21), Q.L.S., Right of Way Engr., Montreal L. H. and P. Cons., Montreal, Que. (*H*) 4017 Grey Ave. (*S 1919*) (*A.M. 1925*)

♂OTTEWELL, Barry, Lieut., B.Sc., M.Sc., (Birmingham '11), D.C. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 460 Monaghan Rd. (*A.M. 1920*)

OUIMET, J. Alphonse, Jr., B.Eng., (McGill '32), 448 Outremont Ave., Outremont, Que. (*S. 1931*)

OULTON, Aubrey Ernest, Asst. Engr., C.N.R., Rm. 601, C.N. Express Bldg., McGill St., Montreal, Que. (*H*) 112 Vivian Ave., Town of Mt. Royal, Que. (*Jr. 1920*) (*A.M. 1923*)

OUTHOUSE, H. W., B.Sc., (N.S.T.C. '33), Tiverton, N.S. (*S. 1933*)

OWENS, Edward James, B.Sc., (N.B. '15), Office Engr. and Purchasing Agent, N.B. Electric Power Comm., P.O. Box 820, Saint John, N.B. (*H*) 15 De Monts St. (*Jr. 1919*) (*A.M. 1925*)

♂†OXLEY, J. Morrow, Major, Partner, Chapman & Oxley, Archts., 372 Bay St., Toronto 2, Ont. (*H*) 12 Foxbar Rd. (*S. 1901*) (*A.M. 1908*) (*M. 1921*)

OXLEY, William M., 12 Foxbar Rd., Toronto, Ont. (*S. 1935*)

PACY, Ernest H., Pres. and Gen. Mgr., Pittsburgh Welding Corp., 1201 Ridge Ave., N.S., Pittsburgh, Pa., U.S.A. (*S. 1907*) (*A.M. 1917*)

PAGET, James R., Sec.-Treas., The Assiniboia Engrg. and Constrn. Co., Ltd., Kenora, Ont. (*A.M. 1920*)

PAGET, Thomas John, Foreman, Public Works, Ontario, Sundridge, Ont. (*A.M. 1921*)

PAINCHAUD, Francois Benoit, B.A.Sc., (Ecole Polytech., Montreal, '13), Avenue Martel, Beauport, Que. (*S. 1912*) (*Jr. 1916*) (*A.M. 1928*)

PAINE, Arthur James Carman, B.Arch., (McGill '10), Staff Architect, Sun Life Assurance Co. of Canada, Montreal, Que. (*H*) 3856 Draper Ave. (*A.M. 1922*)

PAINTER, Gilbert W., B.Eng., (McGill '33), Can. Gen. Elec. Co., Peterborough, Ont. (*H*) Walkerfield House. (*S. 1933*)

PALMER, Fred E., Chief Engr., Sherbrooke Machineries Ltd., Sherbrooke, Que. (*H*) 85 Court St. (*Jr. 1931*)

♂PALMER, Fred'k. Herbert, Lieut., M.C., S.B., C.E., (N.S.T.C. '13), Trade Commr., Dept. of Trade and Commerce, Northcliffe House, Colston Ave., Bristol, England. (*H*) 201 Redland Rd. (*A.M. 1919*)

♂PALMER, John, Lieut., B.Sc., (London '09), Dist. Engr., Can. Westinghouse Co., 1844 William St., Montreal, Que. (*H*) 4192 Marlowe Ave. (*A.M. 1923*)

†PALMER, Robert E., O.B.E., B.A.Sc., (McGill '87), Cons. Engr., 3 Lombard St., London, England. (*S. 1887*) (*A.M. 1891*) (*M. 1907*) (*Life Member*)

PALMER, Robert Kendrick, B.Sc., (Mich.), Chief Engr. and Vice-Pres., i/c Operations, Hamilton Bridge Co., Hamilton, Ont. (*H*) 93 Bold St. (*M. 1919*)

PALMER, Roland Foster, c/o H. S. Barwall, Esq., F.R.C.S., 39 Queen Anne St., Mayfair, London, W.1. (*A.M. 1918*)

PAMENTER, Archibald Francis, B.Sc., (N.S.T.C. '32), Lab. Asst., Imperial Oil Co. Ltd., Dartmouth, N.S. (*H*) 14 James St. (*S. 1931*) (*Jr. 1935*)

PANGMAN, Arthur Henry, B.Sc., (McGill '30), Control Chem., C. E. Frosst & Co., 3571 St. Antoine St., Montreal, Que. (*H*) 117 Aberdeen Ave., Westmount, Que. (*Jr. 1933*)

PAPINEAU, Gustave Jos., B.A.Sc., (Ecole Polytech., Montreal '12), Q.L.S., Private Practice, Rm. 507, Themis Bldg., 10 St. James St. W., Montreal, Que. (*H*) 3221 Maplewood Ave. (*A.M. 1928*)

PAPOFF, Wm. N., B.Sc., (Sask. '33), Trail, B.C. (*S. 1935*)

PAQUET, Jean M., B.A.Sc., (Ecole Polytech., Montreal '34), Sanitary Engr., Prov. Board of Health, Amos, Que. (*S. 1934*)

PARADIS, Alphonse, B.A.Sc., (Ecole Polytech., Montreal '12), Chief Engr., Dept. Highways, Parliament Bldg., Quebec, Que. (*M. 1935*)

♂PARADIS, Antonio, Dftsman, 196 Bougainville Ave., Quebec, Que. (*Affil. 1929*)

PARDOE, Wm. Sprague, B.A.Sc., C.E., (Tor. '06), Prof. of Hydraulics, University of Pennsylvania, Philadelphia, Pa., U.S.A. (*H*) Marion Station, Pa. (*A.M. 1909*) (*M. 1922*)

†PARHAM, John Bright, B.Sc., (McGill '08), 2474–33rd Ave. W., Vancouver, B.C. (*S. 1907*) (*A.M. 1913*)

PARISEAU, Louis S., Supt'g. Engr. of Canals, Prov. of Quebec. (*H*) 3459 Berri St., Montreal, Que. (*A.M. 1887*) (*Life Member*)

♂PARKE, Charles Sager, Lieut., B.Sc., (McGill '18), Asst. Gen. Supt., The Harshaw Chemical Co., 1945 E. 97th St., Cleveland, Ohio. (*H*) 3359 Kenmore Rd., Shaker Heights, Ohio. (*S. 1917*) (*Jr. 1921*) (*A.M. 1930*)

PARKER, Douglas Howard, Chief Engr., The Montreal Daily Star, 245 St James St., Montreal, Que. (*H*) 124 Notre Dame St., St. Lambert, Que. (*Affil. 1933*)

PARKER, John Spence, B.A.Sc., (Tor. '12), Gen. Mgr. of Distrib., Gatineau Power Co., Victoria Bldg., P.O. Box 657, Ottawa, Ont. (*H*) 82 Park Ave. (*A.M. 1928*)

♂PARKER, T. W. W., Lieut., Res. Engr., E. H. James, M.E.I.C., Cons. Engr., 1188 Phillips Place, Montreal, Que. (*H*) 1195 Sherbrooke St. W. (*A.M. 1921*)

PARKIN, J. H., B.A.Sc., (Tor. '12), M.E., (Tor. '19), Asst. Dir., Div. of Engrg. and Physics, National Research Council, 79 Sussex St., Ottawa, Ont. (*H*) 290 Park Rd., Rockcliffe Park. (*M. 1930*)

♂PARKS, John H., Lt.-Col., O.B.E., D.S.O., Div. Engr., Board of Rly. Commrs., Calgary Public Bldg., Calgary, Alta. (*A.M. 1902*) (*M. 1911*)

PARLEE, Rutherford J., B.Sc., (N.B. '31), Lower Millstream, Kings Co., N.B. (*S. 1931*)

PARMELEE, Edward Henry, Mgr., Ferranti Electric Ltd., Rm. 508, Power Bldg., Montreal, Que. (*Affil. 1926*)

PARSONS, Clarence W., Bell Island, Nfld. (*S. 1935*)

PARSONS, E. C., B.Sc., (N.S.T.C. '33), Walton, Hants Co., N.S. (*S. 1931*)

♂PARSONS, Robert H., Lieut., Continental Engr., C. A. Parsons & Co. Ltd., Newcastle-on-Tyne, England. Address: 12 Rue de La Longue Haie, Linkebeek, Belgium. (*M. 1914*)

PARSONS, Roy Henry, B.S.C.E., (Mich. '97), City Engr., Peterborough, Ont. (*H*) 104 Douro St. (*M. 1915*)

PASK, Arthur Henry, B.Sc., (Man. '35), 320 Cote de Liesse Rd., St. Laurent, Que. (*H*) Zeneta, Sask. (*S. 1935*)

♂PASSY, P. de Lacy D., Lt.-Col., (R.M.C., Kingston), P.O. Box 588, Port Hope, Ont. (*S. 1907*) (*Jr. 1914*) (*A.M. 1925*)

♂PATERSON, Alexander Wilson, Capt., Res. Engr., C.P.R., Winnipeg, Man. (*A.M. 1921*)

PATERSON, Elwin L., B.A.Sc., (Tor. '20), Highway Engr., Imperial Oil Ltd., 56 Church St., Toronto, Ont. (*H*) Devonshire Apts., Vancouver, B.C. (*A.M. 1927*)

PATERSON, Raymond Gordon, Can. Western Natural G.L.H. and P. Co., 215–6th Ave. W., Calgary, Alta. (*H*) 718–6th Ave. W. (*Jr. 1932*)

PATON, Charles P., B.Eng., (McGill '35), 53 Wolseley Ave., Montreal West, Que. (*S. 1935*)

PATRICK, Gilbert H., Canal Supt., D.N.R., C.P.R., "Drawer C," Strathmore, Alta. (*A.M. 1917*)

PATRIQUEN, Frank Andrew, B.Sc., (N.B. '31), Junior Engr., Saint John Harbour Commrs., Box 1393, Saint John, N.B. (*H*) 19 Horsfield St. (*S. 1930*) (*Jr. 1934*) (*Sec.-Treas., Saint John Br., E.I.C.*)

♂PATTERSON, Arthur L., Lieut., B.Sc., (McGill '14), Asst. Office Engr., Power Engineering Co., Montreal, Que. (*H*) 4070 Trafalgar Rd. (*S. 1914*) (*A.M. 1926*)

PATTERSON, Earle Bedford, (Tor. '09), Water Power and Water Rights Br., Dept. Mines and Natural Resources, Prov. of Man., Rm. 250, Legislative Bldg., Winnipeg, Man. (*H*) 337 Brock St. (*A.M. 1919*)

PATTERSON, Elmer Goodwin, B.Sc., (Queen's' 24), Northern Electric Co., Ltd., 1261 Shearer St., Montreal, Que. (*H*) 578 Claremont Ave., Westmount, Que. (*Jr. 1927*)

PATTERSON, Gordon N., B.Sc., (Alta. '31), 71 Spadina Rd., Toronto, Ont. (*S. 1930*)

PATTERSON, Harry W., McColl & Patterson, Imperial Bldg., Walkerville, Ont. (*H*) 655 Lincoln Rd. (*Jr. 1919*) (*A.M. 1921*)

PATTERSON, Ian Stewart, B.Sc., (N.S.T.C. '28), Sales Engr., Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) Apt. 21, 5255 Cote St. Luc Rd. (*S. 1928*) (*Jr. 1931*)

PATTERSON, Jas. F., B.Sc., (McGill '18), Supervising Engr., Divn. of the Telephone Apparatus Dept., Northern Electric Co., Ltd., Montreal, Que. (*H*) 652 Prince Albert Ave., Westmount, Que. (*A.M. 1929*)

PATTERSON, Thos. MacMillan, B.A.Sc., (Tor. '25), 22 Byron St., Ottawa, Ont. (*Jr. 1926*)

PATTERSON, Wm. L., 303 Querbes Ave., Outremont, Que. (*S. 1925*)

PATTON, John McDonald, Asst. Bridge Engr., Dept. of Highways, Prov. of Sask., Regina, Sask. (*H*) 2324 Rose St. (*A.M. 1917*)

PAULIN, F. W., (Tor. '07), Pres. and Man'g. Dir., Can. Engineering and Contracting Co., 506 Imperial Bldg., Hamilton, Ont. (*H*) 153 Fairleigh Ave. S. (*S. 1907*) (*A.M. 1913*) (*M. 1922*) (*Member of Council, E.I.C.*)

PAULSEN, R. O., B.Sc., (Man. '29), Dept. Northern Development, Kenora, Ont. (*H*) Erickson, Man. (*Jr. 1930*)

PAYNE, Albert Irving, C.E., (Princeton '96), Mgr., Paynes Ltd., 10321 Jasper Ave., Edmonton, Alta. (*H*) 9933–104th St. (*M. 1920*)

PAYNE, Harold, B.Sc., (Man. '27), 499 Walker Ave., Winnipeg, Man. (*S 1924*) (*Jr. 1929*)

PEACH, Wm. Herbert, C. D. Howe & Co., Port Arthur, Ont. (*H*) 359 North Algoma St. (*S. 1925*)

PEACOCK, Francis Toy, Pres., Peacock Bros., Ltd., University Tower, 660 St. Catherine St. W., Montreal, Que. (*M. 1905*)

PEAKER, William James, (Tor. '04), National Parks of Canada, Dept. Interior, Ottawa, Ont. (*H*) 539 McLeod St. (*A.M. 1921*)

PEARSE, Langdon, A.B., (Harvard), B.Sc., M.Sc., (M.I.T.), Sanitary Engr., The Sanitary Dist. of Chicago, 910 S. Michigan Ave., Chicago, Ill. P.O. Drawer F., Winnetka, Ill. (*M. 1926*)

PEARSON, Vernon, 9840–89th Ave., Edmonton, Alta. (*A.M. 1926*)

♂PEARSTON, Gordon McGregor, Lieut., C.N.R., Rm. 466, Union Sta., Winnipeg, Man. (*H*) 948 Oakenwalk Ave., Fort Garry P.O. (*A.M. 1920*)

♂PEART, John Davidson, B.A.Sc., (Tor. '14), Dist. Sales Engr., Northern Electric Co., Ltd., 65 Rorie St., Winnipeg, Man. (*H*) 85 Lenore St. (*A.M. 1920*)

PEASE, Enson Raymond, B.A., B.Sc., (McGill '08), c/o Montreal Trust Co., 511 Place d'Armes, Montreal, Que. (*H*) St. Bruno, Chambly Co., Que. (*A.M. 1919*)

♂PEDDER, Arthur Gillingham, D.S.M., Dept. of Justice, Kingston Penitentiary, Box 22, Kingston, Ont. (*H*) 111 Livingston Ave. (*A.M. 1921*)

PEDEN, Alexander, Mgr., Dfting Office, Dom. Bridge Co., Ltd., P.O. Box 4016, Montreal, Que. (*H*) 161 Strathearn Ave. N., Montreal West, Que. (*S. 1903*) (*A.M. 1908*) (*M. 1925*)

♂PEDEN, Ernest, Lieut., B.Sc., (McGill '12), 4854 St. Catherine St. W., Montreal, Que. (*S. 1907*) (*Jr. 1913*) (*A.M. 1919*)

PEEBLES, Archibald, B.A.Sc., (B.C. '34), Instr., Dept. of C.E., University of B.C., Vancouver, B.C. (*H*) 2911-W. 15th Ave. (*S. 1927*) (*A.M. 1935*)

PEEK, Robert Lee, Cons. Metallurgist, International Nickel Co. of Canada, Ltd., Copper Cliff, Ont. (*M. 1919*)

PEELE, Percy Frederick, B.A.Sc., (B.C. '24), Sales Engr., Can. Gen. Elec. Co. Ltd., 4th St. W. and 11th Ave., Calgary, Alta. (*H*) 112–8th Ave. N.W. (*A.M. 1934*)

PEFFERS, W. O., B.Sc., (Alta. '31), Capt., R.C.S.C., Camp Borden, Ont. (*S. 1930*) (*Jr. 1934*)

♂PELLETIER, Burroughs, Lieut., B.Sc., (McGill '18), City Engr., City Hall, Chicoutimi, Que. (*H*) 80 Jacques Cartier St. (*S. 1918*) (*A.M. 1923*)

PENDER, William David, Baltimore Rd., Winnipeg, Man. (*A.M. 1908*)

PENFOLD, Douglas Kent, Dist. Engr., Water Rights Br., Prov. Govt. of B.C., Box 547, Kelowna, B.C. (*A.M. 1929*)

PENMAN, Alan Carleton, Purchasing Engr., N.Y. Edison Co., 4 Irving Place, New York, N.Y. (*H*) 1566 Macombs Rd. (*A.M. 1925*)

PEPALL, Jas. Edward, (R.M.C., Kingston '34), 124 Heath St. W., Toronto, Ont. (*S. 1934*)

PEQUEGNAT, Jared Marc, B.Sc., (Queen's '35), 9 Samuel St., Kitchener, Ont. (*S. 1935*)

PEQUEGNAT, Marcel, B.A.Sc., (Tor. '08), O.L.S., D.L.S., Engr. and Mgr., Kitchener Water Works, City Hall, Kitchener, Ont. (*H*) 245 Frederick St. (*Jr. 1912*) (*A.M. 1913*)

PEREGO, Henry Anthony, B.Eng., (McGill '34), 3837 Old Orchard Ave., Montreal, Que. (*S. 1931*)

♂PERKINS, G. C., Address unknown. (*A.M 1920*)

♂PERKINS, Harry William, Project Engr., Minnesota Dept. Highways, 1246 University Ave., St. Paul, Minn., U.S.A. (*H*) Detroit Lakes, Minn. (*A.M. 1919*)

PERLSON, E. H., (R.M.C., Kingston '30), Vegreville Detachment, R.C.M. Police, Vegreville, Alta. (*S. 1930*)

PERRAS, Camille, B.Sc., Montreal Tramways Co., Rm. 320, 159 Craig St. W., Montreal, Que. (*H*) 174 Rheaume Ave., Verdun, Que. (*S. 1925*)

PERRIN, Alfred Thos., Gen. Supt., Sawyer-Massey Ltd., Hamilton, Ont. (*A.M. 1915*) (*M. 1929*)

PERRIN, Vincent (*q*), 86 Caron St., Hull, Que. (*A.M. 1898*)

PERRITON, Douglas Eric, B.Sc., (McGill '22), Mgr., McGregor-McIntyre Iron Wks. Ltd., Box 310, Terminal A, Toronto, Ont. (*H*) 329 Rose Park Drive. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

PERROTT, S. Wright, M.A.I., (T.C.D.), Prof. of Civil Engrg., The University of Liverpool. (*H*) "Rathnew," Church Rd., Upton, Wirral, Cheshire, England. (*M. 1907*)

PERRY, Aubrey Huffman, B.A.Sc., (Tor. '30), Asst. Engr., Dept. of Pensions and Nat. Health, Rm. 22, Bank of N.S. Bldg., St. Catharines, Ont. (*H*) 9 Humber Trail, Toronto, Ont. (*A.M. 1935*)

♂PERRY, Brian R., Lieut., B.Sc., (McGill '15), Cons. Engr., 561 New Birks Bldg., Montreal, Que. (*H*) 5584 Queen Mary Rd. (*S. 1914*) (*A.M. 1923*) (*M. 1931*)

♂PERRY, Kenneth M., Lt.-Col., D.S.O., B.Sc., (McGill '08), The Chateau, 1321 Sherbrooke St. W., Montreal, Que. (*A.M. 1913*)

PERRY, Oliver Mowat, B.Sc., (Queen's '09), Mgr., Windsor Hydro-Elec. System, 111-115 Chatham St. W., Windsor, Ont. (*H*) 1111 Victoria Ave. (*M. 1921*)

PERRY, Philip Carleton, Div. Eng., C.N.R., Regina, Sask. (*H*) 2224 Cameron St. (*A.M. 1920*) (*M. 1935*)

†PETERS, Frederic H., (R.M.C., Kingston), D.L.S., A.L.S., Surveyor General, Dept. Interior, 105 George St., Ottawa, Ont. (*H*) 425 Daly Ave. (*S. 1904*) (*A.M. 1907*) (*M. 1914*)

PETERS, Henry F., B.Sc., (Man. '30), Box 255, Winckler, Man. (*S. 1930*)

PETERS, James H., Rothesay, N.B. (*S. 1935*)

PETERSEN, W. Edgar, B.Sc., (N.B. '32), Efficiency Engr., Port Royal Pulp and Paper Co. Ltd., Fairville, N.B. (*H*) 59 Dufferin Ave., Saint John, N.B. (*S. 1932*)

PETFORD, Herbert Stanley, B.Sc., (McGill '22), Supt., Frontenac Breweries, Ltd., 5930 de Gaspe Ave., Montreal, Que. (*H*) 5694 Hutchison St. (*A.M 1925*)

PETRIE, John B., Mech. Supt., Dom. Steel and Coal Corp., Ltd., Wabana, Nfld. (*A.M. 1919*)

PETURSSON, Franklin, B.Sc., (Man. '28), Div. Engr., Dept. Northern Development, Hawk Lake, Ont. (*S. 1928*) (*A.M. 1935*)

PETURSSON, H. J., B.Sc., (Man. '30), Res. Engr., Dept. Northern Development, Dryden, Ont. (*Jr. 1932*)

PEVZNER, David Isidore, B.Sc., (McGill '22), 5234 Grenier St., Montreal, Que. (*S. 1919*) (*Jr. 1927*)

PHELPS, George, Engr. of Sewers, City of Toronto, Dept. of Works, City Hall, Toronto 2, Ont. (*H*) 362 Roehampton Ave. (*A.M. 1915*)

PHILIP, Patrick, Can. Creosoting Co., Canada Cement Bldg., Montreal, Que. (*A.M. 1917*) (*M. 1922*)

♂PHILLIPS, Hector Somerville, Lieut., Designing Engr., City of Hamilton, Hamilton, Ont. (*H*) 35 Inverness Ave. W. (*A.M. 1915*) (*M. 1922*)

PHILLIPS, Edward Kent, B.Sc., (Sask. '25), M.Sc., '27, D.L.S., S.L.S., Lecturer, Univ. of Saskatchewan, Saskatoon, Sask. (*H*) 1333 Elliott St. (*Jr. 1929*)

PHILLIPS, Frederick Robert, (C.G.I.), 300 Winona Drive, Toronto 10, Ont. (*A.M. 1921*)

PHILLIPS, Fred. R., B.Eng., (McGill '32), 3019 Point Grey Rd., Vancouver, B.C. (*S. 1930*)

PHILLIPS, George, 2540 Windsor Rd., Victoria, B.C. (*A.M 1904*) (*Life Member*)

PHILLIPS, John B., B.Sc., (McGill '27); M.Sc., '28; Ph.D., '30; Lecturer in Chem. Engrg., McGill Univ., Montreal, Que. (*Jr. 1927*) (*A.M. 1934*)

PHILLIPS, Robt. W., B.Eng., (McGill '34), Asst. Engr., Concordia Gold Mining Co., P.O. Box 2550, Timmins, Ont. (*H*) Box 31, Chambly Canton, Que. (*S. 1931*)

PHIPPS, Chas. F., B.Sc., (McGill '24), Designing Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 1205 St. Mark St. (*S. 1924*) (*Jr. 1931*)

PICHÉ, Arthur, (Ecole Polytech., Montreal '30), Engr., Dept. Agriculture, Victoriaville, Que. (*H*) Terrebonne, Que. (*Jr. 1931*)

PICHÉ, Gustave C., M.A., (Laval '23), M.F., Chief of Forest Service, Dept of Lands and Forests, Parliament Bldgs., Quebec, Que. (*H*) 43 St. Foye Rd. (*A.M. 1913*)

PICHÉ, Joseph Pierre, Terrebonne, Que. (*A.M. 1899*)

PICKERING, Albert Ernest, (Tor. '04), Vice-Pres. and Mgr., The Great Lakes Power Co. Ltd., Sault Ste. Marie, Ont. (*H*) 527 Queen St. E. (*M. 1921*) (*Member of Council, E.I.C.*)

PICKRELL, Wm. J., Master Mechanic, N.B. Dist., C.P.R., Box 324, McAdam, N.B. (*A.M. 1919*)

PIDOUX, John Leslie, B.Sc., (Alta. '34), 3506 University St., Montreal, Que (*S. 1930*) (*Jr. 1935*)

PIERCE, John Wesley, O.L.S., D.L.S., M.L.S., Private Practice, Rm. 14, Bank of Commerce Bldg., Peterborough, Ont. (*H*) 492 Homewood Ave. (*M. 1933*)

PIGOT, Chas. Hugh, B.Sc., (McGill '26), Engr., Beauharnois Construction Co., P.O. Box 50, Beauharnois, Que. (*S. 1924*) (*A.M. 1931*)

PIKE, Jas. A., B.A.Sc., (B.C. '30), Engr., Jas. F. McCarthy, Union Mine, Grand Forks, B.C. (*H*) 2426–5th Ave. W., Vancouver, B.C. (*S. 1927*)

PILKEY, Gordon, B.Sc., (Queen's '33), International Harvester Co., Hamilton, Ont. (*H*) 89 Lottridge St. (*S. 1933*)

PIMENOFF, C. J., B.Sc., (McGill '31), 1471 Fort St., Montreal, Que. (*S. 1931*)

PINEAU, Maurice E., Heating and Engrg. Depts., Crane Ltd., 1170 Beaver Hall Sq., Montreal, Que. (*H*) 1377 Fleury St. (*Jr. 1932*)

PINHEY, Chas. H., (Tor. '87), O.L.S., D.L.S., 63 Sparks St., Ottawa, Ont. (*H*) 243 Clemow Ave. (*S. 1887*) (*A.M. 1894*)

PISTREICH, Archie L., B.Eng., (McGill '34), 5638 Waverley St., Montreal, Que. (*S. 1934*)

PITFIELD, B. W., B.Sc., (Alta. '34), Engrg. Dept., Northwestern Utilities Ltd., Edmonton, Alta. (*H*) 10214–125th St. (*S. 1933*)

PITT, Chas. Bertram, B.A.Sc., (Tor. '27), 495 Oriole Parkway, Toronto, Ont. (*S. 1927*)

PITTAWAY, Geo. Henry, 134 Lockee Rd., Dundee, Scotland. (*A.M. 1931*)

♂PITTS, Clarence MacLeod, Lieut., B.Sc., C.E., (McGill '14), Pres. and Gen. Mgr., The People's Gas Supply Co. Ltd.; The Pitts Constrn. Co., Ltd., 2-10 Mill St., Ottawa, Ont. (*H*) 331 Metcalfe St. (*S. 1913*) (*A.M. 1921*) (*Member of Council, E.I.C.*)

PITTS, Gordon McL., B.Sc., B.Arch., M.Sc., (McGill), Maxwell & Pitts, Arch'ts., 1158 Beaver Hall Sq., Montreal, Que. (*H*) Apt. 93, 900 Sherbrooke St. W. (*S. 1908*) (*A.M. 1914*)

PLAMONDON, Adrien, C.E., (Ecole Polytech., Montreal '09), Cons. Engr., 1074 Beaver Hall Hill, Montreal, Que. (*H*) 515 Sherbrooke St. E. (*S. 1907*) (*Jr. 1913*) (*A.M. 1923*)

PLATOU, Otto S., Dalsveien No. 74, Slemdal per Oslo, Norway. (*A.M. 1930*)

PLOW, Gordon Locklin, B.Sc., (McGill '24), 283 Clarke Ave., Westmount, Que. (*S. 1921*)

PLOW, John F., (R.M.C., Kingston '21), Asst. to the Secretary, The Engineering Institute of Canada, 2050 Mansfield St., Montreal, Que. (*H*) 4870 Cote des Neiges Rd. (*S. 1921*) (*Jr. 1928*) (*A.M. 1930*)

PLUMMER, Alex. Alfred, Man. Dir., Plummer Craig, Ltd., 910 Credit Foncier Bldg., Vancouver, B.C. (*S. 1907*) (*Jr. 1916*) (*A.M. 1920*)

♂PLUMMER, Wm. Elfric, 167 Mornington St., Stratford, Ont. (*Jr. 1919*) (*A.M. 1928*)

♂POE, Alexander S., Lieut., B.Sc., (McGill '17), Hydro-Elec. and Struct. Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) Apt. 10, 6171 Sherbrooke St. W. (*S. 1916*) (*A.M. 1926*)

POOLE, Gordon Dean, B.Eng., (McGill '32), 30 Ballantyne Ave. S., Montreal West, Que. (*S. 1932*)

POOLER, G. D., B.Sc., (Queen's '29), Woodroffe, Ont. (*S. 1928*)

POPE, Francis Robt., B.Eng., (McGill '35), 422 Metcalfe Ave., Westmount, Que. (*S. 1933*)

POPE, J. Morley, B.Sc., (McGill '29), 6092 Durocher Ave., Outremont, Que. (*S. 1927*)

PORCHERON, Alphonse D., B.Sc., (McGill '03), Res. Engr., Asbestos Corp. Ltd., Vimy Ridge Mine, Que. (*S. 1904*) (*A.M. 1912*)

♂PORTAS, John, Capt., B.Sc., (London '21), Chief Engr., J. W. Cumming Mfg. Co. Ltd., New Glasgow, N.S. (*A.M. 1927*)

PORTEOUS, J. W., B.Sc., (Alta. '28), Lecturer, University of Alberta, Edmonton, Alta. (*S. 1929*) (*Jr. 1934*)

♂PORTER, Cecil George, Lt.-Col., D.S.O., M.Sc., (McGill '13), C. G. Porter & Co., 215 New Birks Bldg., Montreal, Que. (*H*) 4089 Highland Ave. (*A.M. 1921*)

†PORTER, John Bonsall, Ph.D., D.Sc., (Columbia), 3600 McTavish St., Montreal, Que. (*M. 1896*) (*Life Member*)

PORTER, John Earle, B.A.Sc., (Tor. '15), Plant Engr., Ford Motor Co. of Canada, Ltd., East Windsor, Ont. (*H*) 716 Victoria Ave. (*S. 1914*) (*Jr. 1917*) (*A.M. 1919*)

PORTER, John William, Principal Asst. Engr., Western Reg., C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 339 Academy Rd. (*S. 1902*) (*A.M. 1910*) (*M. 1918*)

PORTER, Sam. G., B.Sc. in C.E., (M.I.T.); M.A., (Baylor), Mgr., Dept. of Nat. Resources, C.P.R., Calgary, Alta. (*H*) 2727 Wolfe St. (*M. 1914*) (*Past-President*)

PORTER, Wm. Thompson, R.R. 2, St. Catharines, Ont. (*A.M. 1930*)

POTTER, Alexander, Cons. Engr., 50 Church St., New York, N.Y. (*H*) Grand View-on-Hudson, Nyack, N.Y. (*A.M. 1893*) (*M. 1917*)

POTTINGER, Alex., B.A.Sc., (B.C. '27), Engr., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) Bartonville, Ont. (*Jr. 1930*)

POTTS, J. E., B.Eng., (McGill '33), Can. National Carbon Co. Ltd., 805 Davenport Rd., Toronto, Ont. (*S. 1933*)

♂POUNDER, John Allan, B.A., (Tor. '12), D.L.S., Engr., International Boundary Comm., Dept. Inter., Geodetic Bldg., Ottawa, Ont. (*H*) 82 Ossington Ave. (*A.M. 1923*)

POUNDER, Thos. Jas., B.Sc., (Man. '28), 116-15th St., Brandon, Man. (*A.M. 1931*)

POWELL, Clarence W., N.S. Technical College, Halifax, N.S. (*S. 1933*)

POWELL, George Giles, B.Sc., (Tor. '03), Deputy City Engr., Works Dept., Toronto, Ont. (*H*) 129 Springhurst Ave. (*A.M. 1907*) (*M. 1913*)

POWELL, John Giles B.A.Sc., (Tor. '32), 11 Duggan Ave., Toronto, Ont. (*S. 1932*)

POWELL, Morley Vincent, B.A.Sc., (Tor. '22), Dftsman. and Calculator, Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 370 London St. (*S. 1921*) (*Jr. 1925*) (*A.M. 1930*)

POWELL, Robert M., (R.M.C., Kingston '35), 290 Coltrin Rd., Rockcliffe Park, Ottawa, Ont. (*S. 1935*)

G.POWELL, W. H., B.Sc., (McGill '09), D.L.S., B.C.L.S., Engr., Greater Vancouver Water Dist., 1303 Bekins Bldg., Vancouver, B.C. (*H*) 4489 Pine Crescent. (*S. 1907*) (*A.M. 1913*) (*M. 1918*)

PRATLEY, Philip L., M.Eng., (Liverpool), Monsarrat & Pratley, Cons. Engrs., 909 Drummond Bldg., Montreal, Que. (*H*) 5 Thornhill Ave., Westmount, Que. (*S. 1907*) (*A.M. 1909*) (*M. 1917*) (*Vice-President, E.I.C.*)

♂PRATT, F. Millen, Capt., M.C., B.A.Sc., (Tor. '12), Mill Engr., Anglo Newfoundland Development Co., Grand Falls, Nfld. (*A.M. 1919*) (*M. 1927*)

PREFONTAINE, Rolland, B.A.Sc., Pres., Solex Co. Ltd., 4060 St. Lawrence Blvd., Montreal, Que.; Cons. Engr. (*S. 1903*) (*A.M. 1911*)

PRENDERGAST, R. M., B.A.Sc., (Tor. '21), Sales Engr., Can. Gen. Elec. Co. Ltd., Ottawa, Ont. (*H*) 412 Sunnyside Ave. (*A.M. 1930*)

PRESCOTT, R. R., B.Sc., (N.S.T.C. '32), Wolfville, N.S. (*S. 1932*)

PRESTON, Wm. Walford, B.Sc., (Queen's '35), Asst. to County Engr., County of Wentworth. (*H*) 25 Walnut St. W., Hamilton, Ont. (*S. 1935*)

PRETE, Louis A. A., Hollinger Consolidated Gold Mines, Ltd., P.O. Box 1565, Timmins, Ont. (*S. 1928*)

PREVOST, Edouard, B.Sc., (Ecole Polytech., Montreal '21), Civil Engr. and Contr., 727 Outremont Ave., Outremont, Que. (*S. 1920*) (*Jr. 1924*) (*A.M. 1932*)

PRICE, Charles Alex., i/c Precise Water Level Div., Can. Hydrographic Service, Dept. Marine, Ottawa, Ont. (*H*) 33 Findlay Ave. (*A.M. 1921*)

PRICE, Fred. Avery, B.Sc., (Queen's '29), (R.M.C., Kingston), Mech. Supt., National Breweries Ltd. (Boswells), Quebec. (*H*) 131 Belvedere Rd., Quebec, Que. (*S. 1924*) (*Jr. 1932*)

PRICE, Harold B., B.Eng., (McGill '32), Can. Fire Underwriters Assoc., Montreal, Que. (*H*) 3566 Lorne Ave. (*S. 1931*)

♂PRICE, J. L. E., Lieut., Pres. and Man'g. Director, J. L. E. Price & Co. Ltd., 410 Architects Bldg., 1135 Beaver Hall Hill, Montreal, Que. (*H*) 3470 Mountain St. (*M. 1932*)

PRICE, Robert W., B.Eng., (McGill '33), 131 St. Clair Ave., Hamilton, Ont. (*S. 1933*)

♂PRICE, Thomas Ernest, Lieut., B.A., B.Sc., (McGill '10), Div. Engr., C.P.R., Vancouver, B.C. (*H*) 6800 East Blvd. (*S. 1906*) (*A.M. 1912*)

PRIEUR, Henri, Sr. Asst. Engr., Canalization Dept., City of Montreal, Rm. 323, City Hall, Montreal, Que. (*H*) 5634 Canterbury Ave. (*S. 1911*) (*Jr. 1916*) (*A.M. 1926*)

PRINGLE, George H., B.Sc., (McGill '26), Asst. Chief Engr., Mead Corp., South Paint St., Chillicothe, Ohio. (*H*) 244 Caldwell St. (*S. 1923*) (*Jr. 1927*)

PRINTZ, Carl J., Royal Vice-Consulate of Norway, 127 Delaware Ave., Toronto 4, Ont. (*A.M. 1925*)

♂PRITTIE, Lloyd Conn, Lieut., B.Sc., (Queen's '12), Patent Attorney, Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 14 Indian Rd. Crescent. (*A.M. 1922*)

PROCTOR, Edward Moore, B.A.Sc., (Tor. '09), Pres., James, Proctor & Redfern, Ltd., Cons. Engrs., 36 Toronto St., Toronto, Ont. (*H*) 177 Inglewood Drive. (*A.M. 1916*) (*M. 1928*)

PRUDHAM, Wm. Merrill, B.A., B.Sc., (McGill '25), Elec. Instrn., Kitchener-Waterloo Vocational School. (*H*) 20 Windermere Court, Kitchener, Ont (*S. 1923*) (*Jr. 1930*)

PRUD'HOMME, Michael Alex., Mech. Engr., The Dom. Dump Car Co., Montreal, Que. (*H*) 780 Champagneur Ave., Outremont, Que. (*A.M. 1928*)

PUDDY, B. B., B.A.Sc., Auditor and Engr., Geo. A. Touche & Co., 67 Yonge St., Toronto, Ont. (*H*) 15 Caldow Rd., Forest Hill Village, Ont. (*S. 1929*)

♂PULLAR, James, Asst. Engr., C.N.R., Moncton, N.B. (*H*) 20 Weldon St. (*A.M. 1921*)

♂PULLEN, Ernest Fleetwood, Major, D.S.O., (Tor. '05), Pres. and Gen. Mgr., Alexo Coal Co., Ltd., Alexo, Alta. (*H*) Oakville, Ont. (*S. 1907*) (*A.M. 1912*)

♂PUNTIN, J. H., Lieut., Arch. and Civil Engr., 407 Darke Block, Regina, Sask. (*A.M. 1918*)

PURCELL, John Wilbert, Elec. Engr., H.E.P.C. of Ont. 620 University Ave., Toronto, Ont. (*H*) Apt. 202, 200 St. Clair Ave. W. (*A.M. 1921*)

PURSER, Ralph C., B.A.Sc., (Tor. '07), D.L.S., O.L.S., 211-5th Ave., Ottawa, Ont. (*A.M. 1919*)

PURVES, Wm. Franklin, B.Eng., (McGill '35), 3505 Jeanne Mance St., Montreal, Que. (*S. 1935*)

PUTMAN, Clarence Victor, B.Sc., (Queen's '15), Chief, Organization Br., Civil Service Commission, Hunter Bldg., Ottawa, Ont. (*H*) 37 Butternut Terrace. (*Jr. 1917*) (*A.M. 1920*)

QUIGLEY, Daniel Hugh, Mine Mgr., Coal Producers, Ltd., Coalhurst, Alta. (*A.M. 1926*)

QUIGLEY, Robt. Webster, B.Eng., (McGill '33), Sales Repres., Can. Industries, Ltd., Noranda, Que. (*H*) 1965 Hamilton St., Regina, Sask. (*S. 1933*)

RACEY, Herbert John, B.Sc., (Queen's '28), Industrial Engr., Crane, Ltd., 3800 St. Patrick St., Montreal, Que. (*H*) 4310 Montrose Ave., Westmount, Que. (*S. 1928*) (*Jr. 1931*)

RACEY, Herbert Wm., Supt. of Box Dept., Dom. Glass Co., Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 4310 Montrose Ave., Westmount, Que. (*A.M. 1919*)

RALEY, Charles, 704 Rayside Ave., Burnaby, New Westminster, B.C. (*A.M. 1921*) (*Life Member*)

RALSTON, W. P., Hill & Dale, Port Hope, Ont. (*S. 1931*)

RAMSAY, Ensley M., Vice-Pres., The Ramsay Co., Patent Attorneys, 273 Bank St., Ottawa, Ont. (*H*) 328 Somerset St. W. (*Jr. 1923*)

RAMSAY, Robert, Mgr., Industrial Dept., Can. Vickers, Ltd., Montreal, Que. (*H*) 217 Percival Ave., Montreal West, Que. (*A.M. 1924*)

RAMSAY, William, Dist. Engr., D.P.W., Williams Lake, B.C. (*A.M. 1920*)

RAMSDALE, Donald O. D., B.Eng., (McGill '33), Estimator, Bepco Canada Ltd., 43-45 Niagara St., Toronto 2, Ont. (*H*) 95 Bedford Rd. (*S. 1933*)

RAMSEY, Kenneth M., B.Sc., (McGill '22), Mgr., Citadel Brick Co., Rm. 421, New Birks Bldg., Montreal, Que. (*H*) 6162 Sherbrooke St. W. (*S. 1921*) (*Jr. 1926*) (*A.M. 1932*)

RAMSTAD, I. A., C.E., (Trond. '28), Royal Norwegian Consulate, Castle Bldg., Montreal, Que. (*Jr. 1930*)

♂RANKIN, Garnet, Lieut., B.A.Sc., (Tor. '15), Tillsonburg, Ont. (*S. 1914*) (*A.M. 1921*)

RANNIE, John Leslie, B.Sc., (Tor. '09), D.L.S., D.T.S., Q.L.S., Chief of Triangulation Div., Geodetic Survey of Canada, Dept. Inter., Ottawa, Ont. (*H*) 19 Oakland Ave. (*A.M. 1918*) (*M. 1922*)

RANSOM, Rosmore Howard, B.Eng., (McGill '35), 22 Windsor Ave., Westmount, Que. (*S. 1931*)

RAPLEY, Blake P., B.Sc., (Queen's '23), Acting Chief Engr., International Petroleum Co. Ltd., Talara, Peru, S.A. (*S. 1922*) (*Jr. 1927*) (*A.M. 1934*)

RAUE, A. G., Malt and Sake Brewing Co. Ltd., 1445 Powell St., Vancouver, B.C. (*H*) 324 N. Boundry Rd. (*S. 1932*)

RAVENOR, Maurice Augustus, Res. Engr., Air Ministry, Hullavington Aerodrome, Wilts., England. (*H*) 165 Prince's Gardens, London, W.3. (*M. 1929*)

RAY, Walter Reginald Gubbins, B.Sc., (McGill '25), Sales Engr., Can. Fairbanks-Morse Co. Ltd., 337 Blvd. Charest, Quebec, Que. (*H*) 45 Ploermel Ave. (*A.M. 1932*)

RAYNER, Geo. Wm., C.E., (Tor. '05), Cons. and Sales Engr., Fuller Gravel, Ltd., 92 MacLennan Ave., Toronto, Ont. (*M. 1920*)

♂RAYNER, Gilbert, Capt., M.C., Partner, Lord, Rayner & Murphy, 277 E. Deerpath Ave., Lake Forest, Ill. (*H*) 595 Washington Rd. (*A.M. 1921*)

♂RAYNSFORD, Robert Parker, Capt., M.E., (Cornell '05), Statistician, International Bond and Share Corpn., 1003 Dom. Square Bldg., Montreal, Que. (*H*) 35 Barat Rd. (*M. 1920*)

READ, Herbert Wm., B.Sc., (McGill '08), c/o R. A. Lasley, Inc., Rm. 1432, Chrysler Bldg., New York, N.Y. (*S. 1907*) (*A.M. 1913*)

REAKES, George, Cons. Engr., 26 Webster St., St. Lambert, Que. (*A.M. 1917*)

REDFERN, Chas Raimond, B.A.Sc., (Tor. '09), Pres., Redfern Construction Co. Ltd., 614 Excelsior Life Bldg., Toronto, Ont. (*H*) 100 Vesta Dr. (*M. 1931*)

♂REDFERN, W. Blaine, B.A.Sc., (Tor. '09), Vice-Pres. and Sec.-Treas., James, Proctor & Redfern, Ltd., Cons. Engrs., 36 Toronto St., Toronto, Ont. (*H*) 458 Russell Hill Rd. (*A.M. 1920*) (*M. 1930*)

REDMOND, Wm. Lawson, 9818-108th St., Edmonton, Alta. (*S. 1934*)

REEKIE, Wm. G., B.Sc., (Man. '26), Lyleton, Man. (*S. 1924*) (*Jr. 1927*)

REES, Frederic, Bell Island, Nfld. (*S. 1935*)

REES, H. S., B.Sc., (Queen's '29), Jr. Aero. Engr., Aeronautical Engrg. Dept., Dept. National Defence, Ottawa, Ont. (*H*) 90 James St. (*S. 1928*)

REEVELY, Fred. Richard, B.A., (Tor. '29), Indust. Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 20 Salisbury Rd., Pointe Claire, Que. (*Jr. 1932*)

REGAN, F. E., Bepco Canada, Ltd., 45 Niagara St., Toronto, Ont. (*H*) 2837 Yonge St. (*Jr. 1930*)

♂REID, Anthony Meredith, Capt., M.C., B.A.Sc., (Tor. '23), Div. Plant Engr., Bell Telephone Co. of Canada, Ltd., 76 Adelaide St. W., Toronto, Ont. (*H*) 71 Alexandra Blvd. (*S. 1919*) (*Jr. 1925*) (*A.M. 1927*)

♂REID, Brian Lee, Lieut., M.C., Res. Engr., Constrn. Dept., C.P.R., Winnipeg, Man. (*A.M. 1922*)

REID, Fraser Daniel, B.Sc., (Queen's '04), Gen. Mgr., The Coniagas Mines Ltd., 1514 Can. Permanent Bldg., 320 Bay St., Toronto, Ont. (*M. 1919*)

REID, Frederick Blair, B.A.Sc., (Toronto '04), D.L.S., Supervisor of Levelling, Geodetic Survey of Canada, Dept. Interior, Ottawa, Ont. (*H*) 57 Powell Ave. (*M. 1919*)

♂REID, G. C., Lieut., M.M., N.S. Dept. of Highways, Halifax, N.S. (*H*) 328 Gottingen St. (*A.M 1919*)

♂REID, James W., B.Sc., (McGill '14), Inspr., Board Rly. Commrs., 525 Calgary Public Bldg., Calgary, Alta. (*H*) 3833-7th St. W. (*A.M. 1929*)

REID, John Alexander, B.Sc., (Queen's '02), Cons. Mining Engr., Rm. 1001, Federal Bldg., 85 Richmond St. W., Toronto, Ont. (*H*) 85 Glendonwynne Rd. (*M. 1919*)

♂REID, John Garnet, Lt.-Col., D.S.O., Asst. Engr., C.P.R., Constrn. Dept., Prince Albert, Sask. (*S. 1905*) (*A.M. 1908*) (*M. 1920*)

REID, John Matthew, B.Sc., (Queen's '32), 97 William St. W., Kingston, Ont. (*S. 1928*)

REID, Kenneth, B.Sc., (McGill '26), Street Lighting Dept., City of Victoria (*H*) 1336 Carnsew St., Victoria, B.C. (*S. 1924*) (*Jr. 1929*) (*Sec.-Treas., Victoria Br., E.I.C.*)

♂REID, Rupert H., Lieut., B.Sc., (McGill '10), Brunner, Mond Canada, Ltd., 80 King St. W., Toronto, Ont. (*S. 1909*) (*Jr. 1913*) (*A.M. 1922*)

♂REID, W. J. W., B.A.Sc., (Tor. '24), Wks. Engr., Otis-Fensom Elevator Co., Ltd., Hamilton, Ont. (*H*) 126 Dalewood Crescent. (*S. 1920*) (*A.M. 1929*)

REID, Wm. Murray, B.A.Sc., (McGill '86), Engr. Mtce. of Way and Structures, Montreal Tramways Co., 159 Craig St. W., Montreal, Que. (*H*) 559 Grosvenor Ave., Westmount, Que. (*S. 1887*) (*A.M. 1895*)

REIKIE, M. Ker Thompson, B.Sc., (Alta. '32), Hudson Bay Mining and Smelting Co. Ltd., Flin Flon, Man. (*S. 1932*)

REILLY, Francis B., Partner, Reilly, Warburton & Reilly, 312 Westman Chambers, Regina, Sask. (*H*) 1548 Garnet St. (*A.M. 1918*)

REINHARDT, G. V., B.Sc., (N.S.T.C. '34), La Have, N.S. (*S. 1932*)

RENOUF, Edward T., B.Sc., (McGill '23), 1550 Pine Ave. W., Montreal, Que. (*S. 1923*)

RENSAA, E. M., Sr. Dftsman., D.P.W., Canada, 3rd Floor, Customs Bldg., Winnipeg, Man. (*H*) 115 Monck Ave. (*A.M. 1932*)

REVELL, Geo. A., B.Sc., (Queen's '30), Ste. 9, 21 Ellery St., Cambridge, Mass., U.S.A. (*S. 1928*)

REYNOLDS, Philip, Chief Engr., The Shell Oil Co. of Canada, Ltd., 21 Dundas Sq., Toronto, Ont. (*H*) 18 Castleview Ave (*M. 1932*)

REYNOLDS, Wm. M., B.Sc., (Queen's '23), Engr., God's Lake Gold Mines Co., God's Lake, Man. (*S. 1920*) (*A.M. 1926*)

REYNOLDS, Geo. Kenly, B.Eng., (McGill '35), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) Apt. 2, 3737 De L'Oratoire. (*S. 1935*)

RHODES, Donald, B.Sc., (McGill '28), Dist. Engr., The Bell Telephone Co. of Canada, Sherbrooke, Que. (*H*) 99-A Portland Ave. (*S. 1926*) (*A.M. 1935*)

RHODES, Fred. Norman, Chief Instr. in Elec., Institute of Technology and Art, Calgary, Alta. (*H*) 912-19th Ave. N.W. (*A.M. 1928*)

♂RHODES, Sir Godfrey Dean, Brig.-Gen., C.B.E., D.S.O., (R.M.C., Kingston '07), Gen. Mgr., Kenya and Uganda Rlys. and Harbours, Nairobi, Kenya Colony, B.E.A. Address: c/o Lloyd's Bank, Cox's and Kings Branch, London, England. (*M. 1922*)

RICE, Herbert Ralph, B.Sc., (Queen's '31), Miner, McIntyre Mines. Ltd., Schumacher, Ont. (H) Box 2405, Timmins, Ont. (S. 1928)

RICE, Walter L., Dftsman., Wks. Dept., City of Toronto, Rm. 320, City Hall, Toronto, Ont. (H) 288 Wolverleigh Blvd. (Jr. 1933)

RICHARDS, Carl Price, 706–24th St., Milwaukee, Oregon, U.S.A. (A.M 1917)

RICHARDS, V. L., B.Sc., (Queen's '32), M.Eng., (McGill '34), Can. Hanson & Van Winkle Co. Ltd., 2 Silver Ave., Toronto, Ont. (H) Apt. 15, 1627 Bloor St. W. (S. 1931)

♂RICHARDSON, Bertram Poineven, Major, Constrn. Engr., 718 University Tower, Montreal, Que. (H) 2393 Madison Ave. (M. 1921)

RICHARDSON, Charles Edward, B.Sc., (McGill), Pres. and Gen. Mgr., C. Richardson & Co., Ltd., Box 1014, St. Mary's, Ont. (S. 1908) (A.M. 1913)

RICHARDSON, Fred Leeds, B.A.Sc., (Tor. '08), Pres., Richardson Constrn Co., Ltd., 10 Adelaide St. W., Toronto, Ont. (H) 316 Glenayr Rd. (A.M 1919)

RICHARDSON, John M., B.Sc., (McGill), Power Corp. of Canada, 355 St. James St. W., Montreal, Que. (H) 1441 Drummond St. (S. 1928)

♂RICHARDSON, Roderick McDougald, B.A., (Dalhousie '22), B.Sc., (McGill '24), Divn. Constrn. Supt., Bell Telephone Co. of Canada, Ltd., Victoria Bldg., Ottawa, Ont. (H) 50 Aylmer Ave. (S. 1922) (Jr. 1926) (A.M. 1930)

RICHARDSON, Wm. G., B.Sc., (Queen's '26), Engr., Monitoring Sta., Can. Radio Broadcasting Comm. Address: R.R. No. 3, Glencoe, Ont. (Jr. 1930)

♂RICHARDSON, Wm. Henry, Lieut., M.C., B.C.E., (Man. '14), City Engr., Kelso, Wash. (H) 707 Columbia St. (S. 1911) (A.M. 1921)

RICHMOND, Wm. Osborn, B.A.Sc., (B.C. '29), M.Sc., (Pittsburgh '32), 542 Huron St., Toronto, Ont. (H) Box 595, Chilliwack, B.C. (S. 1927)

RICKER, Herbert A., B.A.Sc., (Tor. '10), Mech. Engr., Can. Westinghouse Co., Ltd., Hamilton, Ont. (H) 93 Sanford Ave. (M. 1928)

♂RIDDELL, Arthur G., Major, M.C., B.Sc., (McGill '07), 73 Proctor Blvd., Hamilton, Ont. (S. 1907) (A.M. 1913)

RIDDELL, Wm. Forrest, B.Sc., (Man. '24), M.Sc., Asst. Prof., Univ. of Manitoba, Fort Garry, Man. (H) 42 Dundurn Pl., Winnipeg, Man. (S. 1922) (Jr. 1928)

♂RIDER, Ezra B., B.A., B.Sc., Engr., The Metropolitan Water Dist. of S. California, Los Angeles, Calif. (H) 306 Third St. W. (S. 1907) (A.M. 1913)

RIDGERS, Arthur Courtney, Dftsman., Cons. Mining and Smelting Co.. Ltd., Trail, B.C. (H) Rossland, B.C. (Jr. 1929) (A.M. 1935)

RIDLEY, Edmund N., Canal Supt., C.P.R., D.N.R., P.O. Box 269, Strathmore, Alta. (S. 1905) (A.M. 1909) (M. 1929)

♂RIDOUT, Geoffrey Swabey, B.Sc., (Tor. '22), Bell Telephone Co. of Canada, Catherine St., Ottawa, Ont. (A.M. 1931)

♂RIDOUT-EVANS, G. W. F., Major, M.C., 4470 Sherbrooke St. W., Westmount, Que. (S. 1905) (A.M. 1912)

RIEHL, Wm. H., B.A.Sc., (Tor. '20), City Engr., City Hall, Stratford, Ont. (H) 35 Younge St. (S. 1919) (A.M. 1925)

RIGGS, Henry Earle, B.A., (Kansas '86), C.E., (Mich. '10), Hon. Prof., Civil Engrg., Univ. of Michigan; Cons. Engr., 303 West Engineering Bldg., Ann Arbor, Mich. (H) Underdown Rd., Barton Hills. (M. 1935)

RIMMER, Ralph Horton, B.S., (N. Carolina '18), Asst. Supt., Alum. Plant, Aluminum Co. of Canada, Ltd., Arvida, Que. (A.M. 1935)

RINDAL, Harald, C.E., (Trond., '01), 1642–28th Ave. W., Vancouver, B.C. (M. 1918)

RINFRET, Guy R., B.Sc., (McGill '26), Shawinigan Engineering Co., Ltd., 107 Craig St. W., Montreal, Que. (H) Apt. 25, 3436 Shuter St. (S. 1924) (Jr. 1927) (A.M. 1932)

RINTOUL, W. V., B.Sc., (Queen's '35), Burk's Falls, Ont. (S. 1935)

♂RIPLEY, Blair, Lt.-Col., C.B.E., D.S.O., Dist. Engr., Ont. Div., C.P.R., Union Sta., Toronto, Ont. (H) 43 Alvin Ave. (A.M. 1907) (M. 1913)

RIPLEY, H. A., B.Sc., (N.S.T.C. '33), Fairview, Halifax Co., N.S. (S. 1930)

RIPLEY, Wilfred Jamieson, B.Sc., (McGill '14), Asst. Master Mechanic, International Nickel Co. of Canada, Box 260, Copper Cliff, Ont. (A.M. 1923) (M. 1926)

RISLEY, Wilfred Cary, B.S., (Dartmouth '00), Supt. Constrn. and Mtce., Dom. Coal Co., Sydney, N.S. (H) 154 Whitney Ave. (M. 1924)

♂RITCHIE, Alan B., Major, M.C., B.Sc., (McGill '06), Gen. Supt., Consolidated Mining and Smelting Co. of Can., Ltd., Kimberley, B.C. (S. 1904) (A.M. 1911)

RITCHIE, Alexander, Chief Engr. of Constrn., City of Edmonton Power Plant, Edmonton, Alta. (A.M. 1924)

♂RITCHIE, Frederick Avery, Capt., M.C., Engr., Can. Refractories Ltd., Can. Cement Bldg., Montreal, Que. (H) 22 Prince Arthur St., St. Lambert, Que. (A.M. 1920)

RITCHIE, Hugh C., (Tor. '10), City Engr. and Commr., City Hall, Moose Jaw, Sask. (H) 1154 Grafton Ave. (S. 1910) (A.M. 1913)

RITCHIE, Kenneth Schaffner, B.Sc., (N.S.T.C. '31), Nor. Electric Co. Ltd., 86 Hollis St., Halifax, N.S. (H) 85 Morris St. (S. 1929)

ROAST, Harold Jas., (London '02), Owner, Roast Laboratories; Tech. Adviser i/c Operation, Can. Bronze Co. Ltd., 999 Delorimier Ave., Montreal, Que. (H) 532 Prince Albert Ave., Westmount, Que. (M. 1932)

ROBB, Charles A., B.Sc., (McGill '09), M.Sc., (M.I.T. '10), Prof., Mech. Engrg., Univ. of Alberta, Edmonton, Alta. (H) 10 University Campus. (S. 1908) (A.M. 1913) (M. 1923)

ROBB, David W., Dir., Robb Engineering Wks. Ltd., Amherst, N.S. (H) 98 Church St. (M. 1894)

ROBERGE, Antonio, B.A.Sc., (Ecole Polytech., Montreal '26), Asst. to Waterworks Engr., City of Quebec, City Hall, Quebec, Que. (H) Apt. 3, 5 Belvedere Ave. (A.M. 1932)

ROBERTS, Arthur R., M.Sc., Prof. of Mech. Engrg., McGill Univ., Montreal, Que. (H) 1470 St. Matthew St. (S. 1904) (A.M. 1911)

♂ROBERTS, Charles Drury, Jr. Engr. and Designer, City of Toronto, Water Supply Sect., City Hall, Toronto, Ont. (H) 184 Albertus Ave. (A.M. 1921)

ROBERTS, Frederic Morley, B.Sc., (Queen's '24), Indust. Engr., Gen. Elec. Co., 1 River Rd., Schenectady, N.Y. (H) 1174 Waverley Place. (S. 1922) (Jr. 1928)

ROBERTS, J. Frank, B.Sc., (Wisc. '18), Hydr. Engr., Power Corp. of Can., Ltd., 355 St. James St., Montreal, Que. (H) 27 Balfour Ave., Town of Mount Royal, Que. (A.M. 1927)

♂ROBERTS, John Randall, B.Sc., (Vermont '12), Sales Mgr. for Ont., Can. Bitumuls Co. Ltd., Leaside, Ont. (H) 20 Glenview Ave., Toronto, Ont. (Jr. 1916) (A.M. 1917)

♂ROBERTS, Stanley O., D.L.S., Penitentiary Br., Dept. of Justice, Ottawa, Ont. (H) 234 Rideau Terrace. (Jr. 1919) (A.M. 1923)

♂ROBERTSON, A. Ross, Capt., B.A.Sc., (Toronto '09), Mgr., Ont. Div., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (H) 118 Inglewood Dr. (A.M. 1920)

ROBERTSON, Donald G., B.Sc., (Queen's '24), The Coca Cola Co. of Can., Ltd., Toronto, Ont. (H) 7 Cardinal Pl. (Jr. 1922)

ROBERTSON, G. G. D., 205–2nd St. W., Calgary, Alta. (S. 1928)

ROBERTSON, Hugh, Dept. of Highways, Ont., 304 Frederick Ave., Peterborough, Ont. (A.M. 1916)

ROBERTSON, James, B.Sc., (McGill '14), Engr., Pacific Divn., Dom. Bridge Co., Ltd., Vancouver, B.C. (H) 5888 Adera St. (S. 1913) (A.M. 1916) (M. 1935)

†ROBERTSON, J. F., M.Sc., (McGill '04), P.O. Box 502, Copper Cliff, Ont. (S. 1904) (A.M. 1912) (M. 1914)

†ROBERTSON, James McC., B.A.Sc., (Tor),. Cons. Engr., Keefer Bldg., 1440 St. Catherine St. W., Montreal, Que. (H) 618 Carleton Ave., Westmount, Que. (A.M. 1906) (M. 1912)

♂ROBERTSON, Randal Killaly, Capt., B.Sc., (McGill '14), Mgr., The Laprairie Co., Inc., 906 University Tower, Montreal, Que. (H) 369 Belmont Ave., Westmount, Que. (A.M. 1923)

♂ROBERTSON, Robert McFadzean, Capt., B.Sc., (McGill '20), Str'l. Designer, Dom. Bridge Co., Ltd., Lachine, Que. (H) 615 St. Joseph St. (Jr. 1920) (A.M. 1927)

ROBILLARD, Richard F., Asst. to Engr., Grinnell Co. of Can. Ltd., 700 Beaumont St., Montreal, Que. (H) 3076 Maplewood Ave. (S. 1930)

ROBINSON, Denis Owen, B.Sc., (Queen's '23), Sales Engr., Canada Cement Co., Montreal, Que. (H) 11 Relmar Rd., Toronto, Ont. (A.M. 1932)

ROBINSON, Leonard H., C.E., (Tor. '04), Div. Engr., C.N.R., Halifax, N.S. (H) 76 Young Ave. (A.M. 1909) (M. 1927)

ROBINSON, Roy C., (Tor. '08), Div. Engr., C.N.R., P.O. Box 501, Dauphin, Man. (A.M. 1919)

♂ROBINSON, W. C. E., Lieut., Divn. Engr., Laurentian Divn., C.P.R., Park Ave., Montreal, Que. (H) 8016 Western Ave., Montreal West, Que. (Jr. 1922) (A.M. 1926)

ROBINSON, Wm. Morecroft, 23 Market St., Dundas, Ont. (S. 1934)

♂ROBLIN, H. L., Capt., M.C., B.A.Sc., (Tor. '13), Roadmaster, C.N.R., Union Sta., Regina, Sask. (H) 2249 Princess St. (A.M. 1919)

ROBSON, Richard Christopher, Designing Engr., B.C. Sugar Refining Co. Ltd., Vancouver, B.C. (H) 461 St. James Rd. E. (Jr. 1932)

ROBSON, Wm. John, B.Sc., (Alta. '33), B.A.Sc., (Tor. '35), 97 Barton Ave., Toronto, Ont. (S. 1933)

ROBY, Marcus A., Valuation Dept., U.P.R.R., Omaha, Neb. (H) 1503 H St., Lincoln, Neb. (A.M. 1909)

ROCHE, Ivor Francis Rees, B.Sc., (McGill '13), Mgr., Fess Oil Burners of Can., 1405 Drummond St., Montreal, Que. (H) 5553 Queen Mary Rd. (S. 1913) (A.M. 1920)

♂ROCHESTER, Lloyd B., Capt., B.Sc., (McGill '21), Dir., Prospectors Airways Co., Ltd., Rm. 27, Fraser Bldg., 53 Queen St., Ottawa, Ont. (H) 197 Wurtemburg St. (S. 1914) (A.M. 1925)

RODGER, Norman Elliot, B.Sc., (McGill '30), Capt., Dept. National Defence, Ottawa, Ont. (H) Apt. 4, 221 Gladstone Ave. (S. 1930)

RODGER, Wm., Office Engr. and Dftsman., D.P.W. and Mines, N.S., Halifax, N.S. (H) 270 Portland St., Dartmouth, N.S. (A.M. 1913)

ROGERS, Alvah Burphee, Asst. Elec. Engr., Power Engineering Co., Power Bldg., Montreal, Que. (H) 4199 Hingston Ave. (A.M. 1924)

ROGERS, Carl L., 3631 Lorne Cres., Montreal, Que. (S. 1931)

♂ROGERS, Casimir S. G., Major, M.A., (Queen's '01), Bridge Engr., C.N.R., Moncton, N.B. (H) 164 Park St. (A.M. 1910)

ROGERS, Geo. Harold, Gen. Commercial Mgr., The Bell Telephone Co. of Canada, Ltd., 74 Adelaide St. W., Toronto, Ont. (H) 290 Oriole Parkway. (A.M. 1927)

♂ROGERS, Harry George, 118 Howard Park Ave., Toronto 3, Ont. (A.M. 1932)

ROGERS, Howard W., B.Sc., (McGill '31), Can. Blower and Forge Co., Montreal, Que. (H) Apt. 63, 1174 St. Mark St. (S. 1931)

ROGERS, Hubert David, B.Sc., (Queen's '13), Supt., Gananoque Waterworks Comm., Box 570, Gananoque, Ont. (S. 1913) (Jr. 1922)

ROGERS, John Albert, B.Sc., (N.S.T.C. '24), Provincial Paper Ltd., Port Arthur, Ont. (H) 50 Ray Blvd. (S. 1924)

ROLAND, John Wilson, S.B., C.E., (M.I.T.), A.B., (Acadia), Monsarrat & Pratley, Rm. 909, Drummond Bldg., Montreal, Que. (M 1918)

ROLBIN, Max, B.Eng., (McGill '33), 4632 Esplanade Ave., Montreal, Que. (S. 1933)

♂ROLFSON, Orville, Lieut., M.A.Sc., D.L.S., O.L.S., A.L.S., Private Practice, Bartlett Bldg., Windsor, Ont. (S. 1907) (A.M. 1912)

ROLLESTON, Philip R., 196 St. Cyrille St., Quebec, Que. (S. 1923)

ROLPH, Harold, (Tor. '94), C.E., Pres., John S. Metcalf Co. Ltd., 460 St. Helen St., Montreal, Que. (H) 341 Broadway, Lachine, Que. (A.M. 1909) (M. 1920)

♂ROMANES, George, Capt., B.Sc., Redrig, Davidson's Mains, Midlothian, Scotland. (A.M. 1910)

ROME, Robert, Asst. City Engr., City Hall, Vancouver, B.C. (H) 1836 McDonald St. (A.M. 1918)

RONEY, G. V., B.Sc., (Queen's '26), Chief Engr., Farand & Delorme Ltd., 385 St. Martin St., Montreal, Que. (H) Apt. 6, 4277 Western Ave., Westmount, Que. (S. 1925) (A.M. 1935)

ROPER, Chas. P., B.Sc., (N.S.T.C. '28), Res. Engr., Dept. Highways, Halifax, N.S. (H) 362 Morris St. (S. 1928) (Jr. 1932)

RORVIK, Ole Johan, New Consolidated Gold Fields, Ltd., Fox St., P.O. Box 5443, Johannesburg, So. Africa. (A.M. 1929)

ROSE, Alexander, B.Eng., (McGill '35), Analyst, J. T. Donald & Co. Ltd., 1181 Guy St., Montreal, Que. (H) 3806 Wilson Ave. (S. 1934)

ROSE, Alex. A., B.A.Sc., (Tor. '23), Director of Vocational Schools, Timmins, Ont. (Jr. 1926) (A.M. 1928)

ROSE, Hugh Grant, M.A., (Queen's '20), B.A.Sc., (Tor. '23), D.L.S., O.L.S., Box 92, Hensall, Ont. (S. 1921) (Jr. 1924) (A.M. 1928)

♂ROSE, John Thoburn, Lieut., B.A.Sc., (Tor. '15), Jr. Pr. Dev. Engr., Dom. Water Power and Hydrometric Bureau, Winnipeg, Man. (H) 383 Beaverbrook St. (S. 1914) (Jr. 1920) (A.M. 1928)

ROSS, Alexander Bell, 126 Lytton Blvd., Toronto, Ont. (A.M. 1889) (M. 1897) (Life Member)

♂ROSS, Alex. Daniel, Lieut., M.Sc., (M.I.T. '23), Mgr., Can. Comstock Co., Ltd, 1110 New Birks Bldg., Montreal, Que. (H) 5429 Monkland Ave. (A M. 1926)

♂ROSS, Allan Crawford, Capt., B.Sc., (McGill '11), Pres., Ross Meagher Ltd., 7 Echo Dr., Ottawa, Ont. (H) 35 Goulburn Ave. (M. 1933)

ROSS, Archibald Holmes, Ross & Greig, 736 Notre Dame St. W., Montreal. Que. (*H*) 2111 Dorchester St. W. (*M. 1921*)

ROSS, A. LeB., B.Eng., (McGill), Can. Controllers Ltd., 171 Eastern Ave., Toronto, Ont. (*H*) 22 Tichester Rd., Apt. 203. (*S. 1930*)

♂ROSS, A. M., Lieut., Atlin, B.C. (*A.M. 1919*)

ROSS, Sir Charles, Bart., Cons. Engr., 1619 Massachusetts Ave., Washington, D.C. (*M. 1918*)

ROSS, Chas. C., The Hon., B.Sc., (McGill '09), Minister of Lands and Mines, Prov. of Alberta, Administration Bldg., Edmonton, Alta. (*M. 1925*)

ROSS, Donald A., Major, B.A., (Tor. '98), Cons. Engr. and Archt 117 Harvard Ave., Winnipeg, Man. (*A.M. 1904*) (*M. 1910*)

ROSS, Donald, c/o 126 Douglas Ave., Saint John, N.B. (*S. 1935*)

♂ROSS, Donald Grant, B.Sc., (Dalhousie '22), Res. Engr., Saint John Harbour Commrs., Union St. W., Saint John, N.B. (*Jr. 1924*) (*A.M. 1931*)

ROSS, Donald W., Vice-Pres., D. W. Ross & A. Lacroix, Ltd., Rm. 1200, Dom. Square Bldg., Montreal, Que. (*A.M. 1902*) (*M. 1920*)

ROSS, G. V., B.Sc., (N.S.T.C. '32), Lacey Gold Mining Co. Ltd., Chester Basin, N.S. (*H*) P.O. Box 78, Oxford, N.S. (*S. 1930*)

ROSS, Henry James, Jr. Engr. and Designer, City of Toronto, Works Dept., Rm. 320, City Hall, Toronto, Ont. (*H*) 269 Strathmore Blvd. (*A.M. 1921*)

ROSS, Hugh Campbell, B.A.Sc., (Tor. '29), Testing Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 192 Dunn Ave. (*Jr. 1931*)

ROSS, Hugh G., Cons. Engr., 15 Linden Terrace, Ottawa, Ont. (*S. 1925*) (*A.M. 1930*)

ROSS, John W. LeB., Supt. Engr., Sault Ste. Marie Canal, Dept. Rlys. and Canals, Canal Office, Sault Ste. Marie, Ont. (*A.M. 1897*) (*M. 1901*)

ROSS, Jos. Hope, Principal, Western Canada High School, Calgary, Alta. (*H*) 204-27th Ave. N.W. (*A.M. 1922*)

♂ROSS, Kenneth Geo., Major, (Tor. '06), O.L.S., Vice-Pres., Lang & Ross, Ltd., Sault Ste. Marie, Ont. (*H*) 17 Summit Ave. (*A.M. 1919*) (*M. 1932*)

♂ROSS, Malcolm V., B.Sc., (McGill '23), Salesman, Ogden Minton Co. Ltd., 219 University Tower, Montreal, Que. (*H*) 4999 Grosvenor Ave. (*S. 1920*) (*Jr. 1926*) (*A.M. 1930*)

ROSS, Oakland Kenneth, B.Eng., (McGill '34), 1627 Selkirk Ave., Montreal, Que. (*S. 1934*)

K.G.†ROSS, R. A., D.Sc., E.E., (Tor. '90), R. A. Ross & Co., Cons. Engrs., 1062 New Birks Bldg., Montreal, Que. (*H*) 1475 Crescent St. (*M. 1897*) (*Past-President*) (*Life Member*)

ROSS, Robert W., Div. Engr., C.N.R., 9914-104th Ave., Edmonton, Alta. (*H*) 11723-88th St. (*S. 1909*) (*Jr. 1911*) (*A.M. 1918*)

ROSS, Thos. W., B.Eng., (McGill '35), Apt. 8, 1477 Atwater Ave., Montreal, Que. (*S. 1935*)

ROSS, W. Bruce, B.Sc., M.Sc., (McGill), Ph.D., Lecturer in Mathematics, McGill University, Montreal, Que. (*H*) 367 Metcalfe Ave., Westmount, Que. (*S. 1929*) (*A.M. 1935*)

♂ROSS, Wm. Ewart, Lieut., Mgr., Contract Service Dept., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 169 Golfdale Rd. (*Jr. 1920*) (*A.M. 1924*)

♂ROSS-ROSS, Donald de C., Sub-Lieut., R.C.N., B.Sc. in M.E., (McGill '17), Chief Indust. Engr., Howard Smith Paper Mills, Ltd., Cornwall, Ont. (*H*) 123 Adolphus St. (*S. 1916*) (*Jr. 1918*) (*A.M. 1921*) (*M. 1933*)

ROSTRON, John Robert, City Bridge and Str'l. Engr., City of London, City Hall, London, Ont. (*H*) 570 St. James St. (*A.M. 1921*)

ROTHWELL, Jas. M., B.Sc., (B.C. '27), Instr'man., Greater Vancouver Water Dist., Vancouver, B.C. (*H*) 3475 West 18th Ave. (*S. 1927*)

♂ROUNTHWAITE, Francis George, Lieut., B.Sc., (McGill '16), Gen. Mgr. and Dir., The Bermuda Development Co., Ltd., Tucker's Town, Bermuda, B.W.I. (*S. 1916*) (*Jr. 1920*) (*A.M. 1922*) (*M. 1933*)

ROUSSEAU, Gabriel E., B.Sc., (M.I.T. '25), Secy. of the Direction, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*H*) 4325 Christophe Colomb St. (*A.M. 1935*)

ROUTLEDGE, Geo. Graham, Engr. i/c., Water Distribution, City of Toronto, 507 Richmond St. W., Toronto, Ont. (*H*) 332 St. Clair Ave. E. (*A.M. 1921*)

ROUTLY, Herbert Thos., C.E., (Tor. '05), D.L.S., O.L.S., Pres., Routly Construction Co., 21 Dundas Sq., Toronto, Ont. (*H*) 200 Dawlish Ave. (*A.M. 1912*) (*M. 1922*)

ROWAN, John J., B.Sc., (Ecole Polytech., Montreal '35), 162 Friel St., Ottawa, Ont. (*S. 1935*)

ROWAT, Geoffrey H., B.A.Sc., (Tor. '24), Sales Mgr., Can. S.K.F. Co. Ltd., 1057 Bay St., Toronto, Ont. (*S. 1923*) (*Jr. 1928*)

ROWELL, Lorne Archibald, B.Sc., (Sask. '33), B.Eng., (McGill '35), Indust. Engr., Imperial Tobacco Co. Ltd., 3710 St. Antoine St. W., Montreal, Que. (*H*) Apt. 4, 4474 St. Catherine St. W. (*S. 1935*)

ROWLANDS, John Frederick, Deputy Dir., D.P.W., P.O. Box 482, Jerusalem, Palestine. (*A.M. 1918*)

ROWLEY, Harry William, B.Sc., (Mich. State '12), Watermaster, Box 20, Coaldale, Alta. (*A.M. 1922*)

ROY, Eugene, B.A., B.Sc., (Ecole Polytech., Montreal '20), Asst. Engr., City of Outremont, City Hall, Outremont, Que. (*H*) 1064 Bernard Ave. W. (*Jr. 1920*) (*A.M. 1926*)

ROY, J. E., Engr., Dept. of Colonization, Quebec, Que. (*H*) 129 Lockwell St. (*A.M. 1919*)

ROY, Leo, B.Sc., (Ecole Polytech., Montreal '30), Shawinigan Water and Power Co., Montreal, Que. (*H*) 4298 Adam St. (*S. 1931*)

ROY, P., B.Sc., (Queen's '29), 9 Second Ave., Ottawa, Ont. (*S. 1928*)

ROYER, Jacques, 1990 Rachel St. E., Montreal, Que. (*S. 1934*)

RUDDICK, James, James Ruddick Engrg. and Constrn. Co. Ltd., 414 Power Bldg., Quebec, Que. (*H*) Apt. 3, 123 Park Ave. (*M. 1916*)

RULE, Albert E., Jr., B.A.Sc., (Tor. '34), Richardson Constrn. Co. Ltd., 10 Adelaide St. E., Toronto, Ont. (*H*) 100 Humbercrest Blvd. (*S. 1934*)

RUNCIMAN, Arthur Salkeld, (Tor. '11), E.E., (Tor. '28), Supt. of Transm. Lines, Shawinigan Water and Power Co., Montreal, Que. (*H*) 68 Curzon St., Montreal West, Que. (*A.M. 1919*)

RUNDLE, Lewis Philip, B.S., (E.E.), Elec. Engr., Welland Ship Canal, St. Catharines, Ont. (*H*) 28 Academy St. (*M. 1932*)

RUSH, Walter Albert, Gen. Supt. of Radio, Dept. of Marine, Rm. 218, Hunter Bldg., Ottawa, Ont. (*H*) 200 Rideau Terrace. (*A.M. 1921*)

RUSSEL, William B., (Tor. '91), Dir., Chambers, McQuigge & McCaffray, Ltd., 1104 Hermant Bldg., Toronto, Ont. (*H*) 189 Wanless Ave. (*S. 1888*) (*A.M. 1899*) (*M. 1903*) (*Life Member*)

RUSSELL, Allan Hugh, City Engr., Sault Ste. Marie, Ont. (*H*) 21 Lansdowne Ave. (*Jr. 1922*) (*A.M. 1925*)

RUSSELL, Benjamin, B.Sc., (McGill '09), D.L.S., Chief Engr., Water Development Committee, Swift Current, Sask. (*S. 1907*) (*A.M. 1913*) (*M. 1924*)

RUSSELL, C. Jas., Supt., Rural Dist., Great Lakes Power Co. Ltd., Sault Ste. Marie, Ont. (*H*) 165 Church St. (*A.M. 1925*)

RUSSELL, John Arthur, Chief Mech. Engr., Dom. Coal Co. Ltd., Sydney, N.S. (*H*) 418 Whitney Ave. (*Jr. 1930*)

♂RUSSELL, John Hartley, Engr., Russell Constrn. Co., Ltd., 504 Harbour Administration Bldg., Toronto, Ont. (*H*) 48 Bedford Park Ave. (*Jr. 1920*) (*A.M. 1925*)

♂RUST, Frederick Charles, Supt., Patricia Dist., H.E.P.C. of Ont., Goldpines, Ont. (*S. 1909*) (*Jr. 1913*) (*A.M. 1922*)

♂RUST, Henry P., B.A.Sc., (Tor. '02), 1430 Lincoln Liberty Bldg., Philadelphia, Pa. (*H*) 8711 Shawnee St. (*S. 1899*) (*A.M. 1905*) (*M. 1914*)

RUTHERFORD, Andrew Scott, (R.M.C., Kingston), B.Sc., (McGill '22), J. L. E. Price & Co. Ltd., 410 Architects Bldg., Beaver Hall Hill, Montreal, Que. (*H*) 4059 Highland Ave. (*S. 1920*) (*A.M. 1928*)

RUTHERFORD, Stewart F. (*g*), B.Sc., (McGill '96), Commr., Quebec Streams Comm., 222 New Court House, Montreal, Que. (*H*) 465 Mt. Pleasant Ave., Westmount, Que. (*A.M. 1899*)

RUTLEDGE, Lewis Traver, B.A.Sc., (Tor. '09), Assoc. Prof. of Mech. Engrg., Queen's Univ., Kingston, Ont. (*H*) 262 University Ave. (*Jr. 1912*) (*A.M. 1914*) (*M. 1921*)

RUTLEDGE, Michael Jos., B.Sc., (N.B. '08), City Mgr., City Hall, St. Lambert, Que. (*Jr. 1916*) (*A.M. 1919*) (*M. 1923*)

♂RUTLEY, Frederick George, Capt., B.A.Sc., (Tor. '12), Vice-Pres., The Foundation Co. of Canada, Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*H*) 18 Anwoth Rd., Westmount, Que. (*A.M. 1921*)

♂RUTTAN, John Douglas, Mgr., Chipman Chemicals Ltd., 1040 Lynn Ave., Winnipeg, Man.; also Engr., Town of Tuxedo, Man. (*H*) 587 Stradbrooke Ave. (*A.M. 1921*)

♂RYAN, C. Cedric, Capt., M.C., M.Sc., (McGill '14), Res. Engr., B.C. Pulp and Paper Co. Ltd., Port Alice, B.C. (*H*) 2744-1st Ave. W., Vancouver, B.C. (*S. 1913*) (*A.M. 1924*)

RYAN, Charles Wilbert, B.Sc., (McGill '16), 3900 Graystone Ave., New York, N.Y. (*S. 1915*) (*Jr. 1920*) (*A.M. 1927*)

RYAN, Edward A., B.Sc., E.E., (McGill '12), Cons. Engr., 1188 Phillips Place, Montreal, Que. (*H*) 4721 Western Ave., Westmount, Que. (*A.M. 1919*) (*M. 1927*) (*Member of Council, E.I.C.*)

RYBKA, Karel R., B.Eng., Cons. Engr., 1154 Beaver Hall Sq., Montreal, Que. (*A.M. 1931*)

RYCKMAN, John Hamilton, (Tor. '06), Asst. Engr., Water Works Design, Bureau of Engrg., D.P.W., City of Chicago, Chicago, Ill. (*H*) 7835 Saginaw Ave. (*A.M. 1917*) (*M. 1920*)

RYDER, Frederick J., B.Sc., (McGill '29), Motor Products Corpn., Walkerville, Ont. (*H*) 1430 Giles Blvd. E., Windsor, Ont. (*S. 1928*)

RYLAND, Herman G. 9 St. Hubert St., Shawinigan Falls, Que. (*S. 1933*)

SABOURIN, A. G., (Ecole Polytech., Montreal), Dist. Engr., D.P.W., Canada, Post Office Bldg., Quebec, Que. (*H*) Monument, Que. (*A.M. 1914*)

SADLER, Robert F., Chatham, N.B. (*S. 1935*)

♂SAGAR, Wm. Lister, Lieut., B.A.Sc., (Tor. '18), Lecturer in C.E., Univ. of Toronto, Rm. 13, Electrical Bldg., Univ. of Toronto, Toronto, Ont. Engr. of Tests, Industrial Laboratories Ltd. (*A.M. 1926*)

SAINT JACQUES, Jean, B.Sc., (McGill '31), Quebec Power Co., P.O. Box 730, Quebec, Que. (*H*) 49 Moncton St. (*S. 1931*)

SALE, Chas. P., B.A.Sc., (Tor. '21), Sale & Sale, 303 Murray Bldg., Windsor, Ont. (*H*) 187 Partington Ave., Sandwich, Ont. (*S. 1921*) (*Jr. 1923*) (*Affil. 1930*)

SALTER, Ernest Milton, B.A.Sc., (Tor. '11), Safety Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 269 London Rd. (*S. 1911*) (*Jr. 1912*) (*A.M. 1916*)

♂SALTMAN, Fred Everett, B.Sc., (Dalhousie '22), B.Sc., E.E., (N.S.T.C. '24), M.E., '33, Res. Engr., Dept. of Highways, N.S., New Glasgow, N.S. (*H*) Mahone Bay, N.S. (*A.M. 1925*)

†SAMMETT, Matthew A., B.Sc., Rm. 329, Sacred Heart Hospital, Cartierville, Que. (*A.M. 1904*)

♂SAMPSON, Cyrus Dexter, Engr., International Coal Co. Ltd., Westville, N.S. (*Jr. 1923*) (*A.M. 1934*)

♂SAMPSON, Wm. T., Mine Supt., Wright Hargreaves Mines, Ltd., Kirkland Lake, Ont. (*M. 1932*)

SAMUEL, Myron, Prop., Empire Engrg. Co., 11 Wellington St. E., Toronto, Ont. (*H*) 118 Spadina Rd. (*Affil. 1931*) (*A.M. 1935*)

SANCTON, Geo. Edward, Gen. Mgr., Fraser & Chalmers of Canada, Ltd., Rm. 402, 1411 Crescent St., Montreal, Que. (*M. 1934*)

SANCTON, R. A., Kilmar, Que. (*S. 1931*)

SANDERSON, A. U., B.A.Sc., (Tor. '09), Chief Engr., Water Supply Sect., Dept. of Works, City Hall, Toronto, Ont. (*H*) 45 Poplar Plains Cres. (*A.M. 1921*)

♂SANDERSON, C. J. Lacy, Capt., Engr., Dundurn Camp, Dundurn, Sask. (*A.M. 1921*)

SANDILANDS, A., Jr., B.Sc., (Man. '34), Crompton-Parkinson Ltd., Chelmsford, Essex, England. (*S. 1931*)

♂SANDWELL, Percy, Lieut., Prop., Sawford & Sandwell, 850 Hastings St. W., Vancouver, B.C. (*H*) 1049 Nanton Ave. (*A.M. 1923*)

SANDWELL, Percy Ritchie, B.A.Sc., (B.C. '35), 139 Brock Ave. S., Montreal West, Que. (*Jr. 1935*)

SANGER, John William, Chief Engr., City of Winnipeg Hydro-Electric System, 55 Princess St., Winnipeg, Man. (*H*) 251 Elm St. (*A.M. 1921*)

SANGSTER, Andrew Gordon, (R.M.C., Kingston '31), B.Eng., (McGill '33), 3592 University St., Montreal, Que. (*S. 1933*)

SANSOM, Ralph Thos., B.Sc., (N.B. '35), P.O. Box 614, Campbellton, N.B. (*S. 1935*)

SARAULT, Gilles E., B.Eng., (McGill '34), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) Apt. 19, 1490 Bernard Ave. (*S. 1932*)

SARGENT, Chas. D., 224 Second St. E., Cornwall, Ont. (*A.M. 1890*) (*M. 1894*) (*Life Member*)

SAUDER, Penrose Melvin, (Tor. '04), Project Mgr., Lethbridge Northern Irrigation Dist., P.O. Box 630, Lethbridge, Alta. (*H*) 639-11th St. S. (*A.M. 1908*) (*M. 1914*)

SAUER, G. Douglas, B.Sc., (McGill '31), (R.M.C., Kingston), Designer, Beauharnois Light, Heat and Power Co., Box 50, Beauharnois, Que. (*S. 1930*) (*A.M. 1934*)

SAUER, Max V., B.A.Sc., (Tor. '03), Hydraulic Engr. and Gen. Supt., Generating Stations, Montreal L., H. & P. Cons., Power Bldg., Montreal, Que (*H*) Beauharnois, Que. (*S. 1904*) (*M. 1913*)

SAUNDERS, C. S., Gen. Mgr., Shawinigan Engineering Co. Ltd., Power Bldg , Montreal, Que. (*H*) 215 Brock Ave., Montreal West, Que. (*A.M 1922*)

SAUNDERS, J. Bruce, B.Sc., (Queen's '23), Prop., Saunders Electric Co., 167 Princess St., Kingston, Ont. (*H*) 124 Beverley St. (*S. 1922*)

SAUNDERS, Malcolm Burgoyne, Sales Engr., Wm. Kennedy & Sons, Ltd., Owen Sound, Ont. Address: New Liskeard, Ont. (*A.M. 1920*)

♂SAUNDERS, Max Gordon, B.A., (Acadia '16), M.A., '17, B.Sc., (N.S.T C. '23), Mech. Supt., Aluminum Co. of Canada, Arvida, Que. (*A.M. 1933*)

♂SAUNDERS, Reginald Geo., Capt., M.C., Cons. Engr., E. L. Cousins, Harbour Comm. Bldg., Foot of Bay St., Toronto, Ont. (*H*) 17 Inglewood Dr. (*S. 1907*) (*Jr. 1911*) (*A.M. 1913*) (*M. 1919*)

♂SAUNDERS, Walter L., Lieut., Res. Engr., Dept. of Highways, Ont., 295 Albert St., Ottawa, Ont. (*H*) 82 Belmont Ave. (*S. 1910*) (*Jr. 1913*) (*A.M. 1920*)

SAUVAGE, Robt., B.Sc., (Ecole Polytech., Montreal '24), Dept. P.W. and L., Parliament Bldgs., Quebec, Que. (*H*) Apt. 9, 240 St. John St. (*Jr. 1925*) (*A.M. 1934*)

SAVAGE, Palmer E., B.Sc., (McGill '31), M.Eng. '34, Strl. Designer, Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 130 Brock Ave S., Montreal West, Que. (*S. 1930*)

SAVARY, Romeo J. L., (Laval), Q.L.S. and C.E., 36 de Salaberry Ave , Quebec, Que. (*S. 1913*) (*Jr. 1916*) (*A.M. 1917*)

SAWLE, Ross T., B.Sc., (Queen's '34), 23 Fraser St., Welland, Ont. (*S. 1934*)

SCADDING, Simcoe C., B.A.Sc., (Tor. '22), Statistician, Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 4539 Oxford Ave. (*S. 1920*) (*Jr. 1930*)

SCANLAN, J. J. Rene, B.Sc., (McGill '26), Engr., Milton Hersey Co Ltd., Montreal, Que. (*H*) 01088 Charlevoix St. (*S. 1925*) (*A.M. 1935*)

SCHEAR, Philip M., B.Eng., (McGill '35), 4215 St. Urbain St., Montreal, Que. (*S. 1935*)

SCHEMAN, Carl H., B.S., (Iowa '10), Pres. and Gen. Mgr., Horton Steel Works, Ltd., Fort Erie, Ont. (*A.M. 1920*) (*M. 1925*)

SCHIPPEL, Walter H., B.Sc., (McGill '20), Lecturer in Elec. Engrg., McGill Univ., Montreal, Que. (*H*) Apt. 22, 4970 Queen Mary Rd. (*Jr. 1924*)

SCHLEMM, Leonard E., Town Planning Consultant, Rm. 100-01, 1178 Phillips Pl., Montreal, Que. (*A.M. 1913*) (*M. 1923*)

SCHNEDAR, Clarence C., Lydden, Sask. (*S. 1931*)

SCHNELLER, A. G E., B.Sc., (Sask. '33), Hollinger Consolidated Gold Mines, Box 2481, Timmins, Ont. (*S. 1931*)

SCHNYDER, Max, B.Eng., (McGill '35), Linde Can. Refrigeration Co. Ltd., Montreal, Que. (*H*) Apt. 2, 1477 Fort St. (*S. 1934*)

SCHOENI, Willy, (Federal Polytech., Zurich '26), Elec. Engr., Cansfield Elec. Wks., Ltd, 250 Geary Ave., Toronto, Ont. (*H*) 235 Clendenan Ave. (*Jr. 1928*)

SCHOFIELD, Robert J. G., B.Eng., (McGill '35), Brunner, Mond Canada, Ltd., Amherstburg, Ont. (*S. 1935*)

SCHOFIELD, Wm., B.Eng., (McGill '33), Dftsman, Howard Smith Paper Mills, Ltd., Cornwall, Ont. (*H*) 135 Third St. E. (*S. 1931*)

SCHREIBER, John W., M.E., (Pittsburgh '07), Asst. Chief Engr., Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa. (*H*) 6320 Burchfield Ave. (*M. 1926*)

SCHULTE, Theodore, Supt., Telephones and Elec. Equipment, D.N.R., C.P.R., P.O. Box No. 1, Strathmore, Alta. (*A.M. 1923*)

SCHULTZ, Chas. D., B.A.Sc., (B.C. '31). Forest Surveys Divn., Dept. of Lands, Victoria, B.C. (*H*) 3329-24th Ave. W., Vancouver, B.C. (*S. 1928*) (*Jr. 1922*)

SCOBIE, A. Gordon, 472 King William St., Hamilton, Ont. (*S. 1934*)

SCOTT, Alexander, Div. Engr., C.N.R., Charlottetown, P.E.I. (*H*) 18 Euston St. (*A.M. 1921*)

♂SCOTT, Alex. Gordon, B.Sc., (McGill '14), Footwear Findings of Can., Ltd., Cowansville, Que. (*A.M. 1920*)

♂SCOTT, Allen N., Capt., M.C., B.Sc., (McGill '12), Constrn. Engr., Electrical Comm., City of Montreal, Rm. 717, Tramway Bldg., Montreal, Que. (*H*) 111 Westminster Ave. N., Montreal West, Que. (*S. 1911*) (*A.M. 1921*)

SCOTT, Daniel S., 517 St. Cyrille St., Quebec, Que. (*S. 1907*) (*A.M. 1910*)

SCOTT, Hew M., Pres., Hew M. Scott, 1103 Millwood Rd., Leaside, Ont. (*H*) 52 Eastbourne Ave., Toronto, Ont. (*M. 1920*)

SCOTT, Lloyd G., B.Sc., (Man. '32), Hudson's Bay Co., Hudson's Bay House, 79 Main St., Winnipeg, Man. (*S. 1930*)

SCOTT, Walter Kingston, Dftsman., Farand & Delorme, 385 St. Martin St., Montreal, Que. (*H*) 5706–7th Ave., Rosemount, Que. (*A.M. 1919*)

SCOTT, Walter Moffatt, B.A.Sc., (McGill '95), Chairman of Commrs., Greater Winnipeg Water Dist., Winnipeg, Man. (*H*) 188 Montrose St., River Heights (*S. 1896*) (*A.M. 1902*) (*M. 1906*)

♂SCOTT, Wm. Beverly, Lieut., B.Sc., (McGill '20), Mgr., Laurentide Divn., Consolidated Paper Corp., Ltd., Grand'Mere, Que. (*Jr. 1920*) (*A.M. 1929*)

SCOTT, William Gordon, B.Sc., (McGill '08), Engr., Howard Smith Paper Mills, Ltd., 407 McGill St., Montreal, Que. (*H*) Apt. 61, 3515 Durocher St. (*A.M. 1922*)

♂SCOTT, W. O C., B.A.Sc., M.A.Sc., (B.C. '23), The Mining Corpn. of Canada. Atlin, B.C. (*H*) 2-1414 West 14th Ave., Vancouver, B.C. (*S. 1922*) (*Jr. 1926*) (*A.M. 1931*)

SCOULAR, W. B., B.Sc., (Glasgow '23), Designer, Dom. Bridge Co., Ltd., Montreal, Que. (*H*) 5255 Cote St. Luc Rd. (*A.M. 1930*)

SCRYMGEOUR, Chas., Refinery Engr., Imperial Oil Refineries, Ltd., Box 490, Dartmouth, N.S. (*A.M. 1931*)

SCRYMGEOUR, D. Stuart, Chief Dftsman., London Structural Steel Co. Ltd., Burslem St., London, Ont. (*H*) 1285 Dundas St. (*A.M. 1935*)

SEABORNE, Rolfe L., B.A.Sc., (Tor. '16), Mgr., Woodlands, Mersey Paper Co., Ltd., Box 306, Liverpool, N.S. (*S. 1914*) (*A.M. 1920*)

♂SEAMAN, L. N., Lt.-Col., B.Sc., (Acadia '10), M.A., '12, Officer i/c Timber Testing, Forest Research Institute, Dehra Dun, United Provinces, India. (*A.M. 1920*) (*M. 1925*)

♂SEARS, John Edgar, Asst. Engr., Welland Ship Canal, Sect. 6, Dept. of Rlys and Canals, Port Robinson, Ont. Address: Box 520, Thorold, Ont. (*A.M. 1921*)

SEARS, John Jos., B.Sc., (N.S.T.C. '16), Field Engr., N.S. Light and Power Co., Ltd , Capitol Theatre Bldg., Halifax, N.S. (*H*) 87 Birmington St. (*A.M. 1924*)

SEELY, Wallace Errol, B.Sc., (N.B. '30), 651 Union St., Fredericton, N.B. (*S. 1929*) (*Jr. 1935*)

SEENS, John William, B.Sc., (Mich. '04), Pres. and Gen. Mgr., Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 1220 Longfellow Ave., Detroit, Mich. (*A.M. 1908*)

♂SEFTON, Frank Hugh Cotteril, Chief Dftsman, Way Dept., Toronto Transportation Comm., Toronto, Ont. (*H*) 393 Glencairn Ave. (*A.M. 1921*)

♂SEGRE, Beresford Henry, Lieut., B.A.Sc., (Tor. '13), D.L.S., Surveys Engr., Topographical Surveys, Dept. Interior, Ottawa, Ont. (*H*) 132 Fentiman Ave. (*A.M. 1921*)

♂SEIBERT, Frederick Victor, B.A.Sc., (Tor. '12), O.L.S., D.L.S., A.L.S., S.L.S., Supt., Nat. Res. Dept., C.N.R., Winnipeg, Man. (*H*) 11-B Locarno Apts. (*A.M. 1920*) (*M. 1922*)

♂SERSON, Harold Victor, Lieut., (Tor. '05), Asst. Mech. Engr., Dept. of Justice, Penitentiary Br., Confederation Bldg., Ottawa, Ont. (*H*) 58 Willard Ave. (*A.M. 1909*)

SEVIGNY, Jos. Alfred, Asst. to Plant Engr. and Chief Dftsman., St. Lawrence Paper Mills Co., Ltd., Three Rivers, Que. (*H*) 733 St. Cecile St. (*S. 1925*) (*Jr. 1933*)

SEXTON, Jack Kenneth, B.Sc., (Sask. '28), 2064 Princess St., Regina, Sask. (*S. 1927*) (*Jr. 1929*) (*A.M. 1934*)

SEYBOLD, Hugh G., B.Eng., (McGill '33), Hudson's Bay Co. (Mackenzie River Transport), Hudson's Bay House, Main St., Winnipeg, Man. (*S. 1933*)

SEYMOUR, Horace L., C.E., B.A.Sc., (Tor. '13), D.L.S., O.L.S., Cons. Engr., 87 Cartier St., Ottawa, Ont. (*A.M. 1912*) (*M. 1923*)

SEYMOUR, Wm., B.S., (Mich. '04), Supt., Coke Ovens, Algoma Steel Corp'n., Sault Ste. Marie, Ont. (*H*) 141 Upton Rd. (*M. 1921*)

SHACKELL, Sameul Wm., C.N.R., Montreal, Que. (*H*) 656 St. Joseph St., Lachine, Que. (*S. 1908*) (*Jr. 1913*) (*A.M. 1919*)

SHANKS, Graham Lawson, B.Sc., (Man. '12), M.S., Assoc. Prof., Agricultura Engrg., Univ. of Manitoba, Winnipeg, Man. (*H*) 848 North Drive, Fort Garry, Man. (*A.M. 1925*)

SHANKS, Victor, B.A.Sc., (McGill '35), 2 Le Roy Ave., Toronto, Ont. (*S. 1932*)

♂SHANLY, James, Lieut., Asst. Gen. Supt., Price Bros. & Co., Ltd., P.O. Box 228, Kenogami, Que. (*Jr. 1920*) (*A.M. 1933*)

SHANNON, John, Agent and Engr., Sir Wm. Arrol & Co., Ltd., 85 Dunn St., Bridgeton, Glasgow, Scotland. (*H*) 11 Glencairn Dr., Pollokshields, Glasgow, Scotland. (*A.M. 1913*)

SHARP, Wm. Gray, B.Sc , (Alta. '33), Didsbury, Alta. (*S. 1933*)

SHARPE, Albert Ernest, Asst. Engr., C.P.R., North Battleford, Sask. (*H*) 1132 York St. (*A.M. 1909*) (*M. 1922*)

SHARPE, D. Neville, (Tor. '11), M.L.S. and D.L.S., Surveyor and Engr., Man., Natural Resources, 364 Legislative Bldg., Winnipeg, Man. (*H*) 121 Sherburn St. (*S. 1907*) (*A.M. 1913*) (*M. 1927*)

SHARPE, Jas. MacDonald, Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 92-A 4th St. (*S. 1924*)

SHATFORD, R. Grant, B.Sc., (Dalhousie '33); B.Sc., (N.S.T.C. '35), 20 Thompson St., Dartmouth, N.S. (*S. 1932*)

SHAW, Charles Berford, P.O. Box 752, Thorold, Ont. (*Jr. 1919*) (*A.M. 1922*)

SHAW, Gerald E., M.Sc., (McGill '25), Asst. Engr., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*S. 1921*) (*Jr. 1928*) (*A.M. 1929*)

†SHAW, John Aitken, B.Sc., (McGill), Gen. Elec. Engr., C.P.R., Montreal, Que. (*H*) 448 Lansdowne Ave., Westmount, Que. (*S. 1899*) (*A.M. 1907*) (*M. 1917*)

♂SHEARER, George W., Major, M.Sc., (McGill '07), Pres., James Shearer Construction Co., 1400 Shearer St., Montreal, Que. (*H*) 4754 Roslyn Ave. (*S. 1907*) (*A.M. 1912*)

SHEARWOOD, Alexander P. B., B.A., B.Eng., (McGill '32), Asst. Engr., National Steel Car Corp., 621 St. James St., Montreal, Que. (*H*) 120 Aberdeen Ave., Westmount, Que. (*S. 1929*) (*A.M. 1935*)

†SHEARWOOD, Fred. Perry, Chief Engr., Dom. Bridge Co., Ltd., Montreal, Que. (*H*) 120 Aberdeen Ave., Westmount, Que. (*A.M. 1892*) (*M. 1904*) (*Past-President*)

♂SHELDEN, Wm. Leslie, Designing Engr., Water Supply Sect., Wks. Dept., City of Toronto, Rm. 320, City Hall, Toronto, Ont. (*H*) 460 Avenue Rd. (*A.M. 1935*)

♂SHELTON, James Frederick, Dftsman., Dept. Rlys. and Canals, Welland Ship Canal, St. Catharines, Ont. (*H*) Martindale Rd. (*Jr. 1922*)

♂SHEPHERD, David, Capt., B.Sc., (Edinburgh '05), Vice-Pres., Campbell & Shepherd, Ltd., 1608 Northern Ontario Bldg., Toronto, Ont. (*H*) 73 Lawton Blvd. (*A.M. 1921*)

♂SHEPHERD, Hugh W. R., 1205 St. Mark St., Montreal, Que. (*S. 1909*) (*Jr. 1914*) (*A.M. 1926*)

SHEPPARD, Norman E. D., B.A.Sc., (Tor. '14), Publications Mgr., The Engineering Institute of Canada, 2050 Mansfield St., Montreal, Que. (*H*) 8020 Western Ave., Montreal West, Que. (*S. 1914*) (*A.M. 1916*)

SHERMAN, Harry B., Operating Supt., The Calgary Power Co., Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 2917 Carlton St. (*A.M. 1919*)

♂SHERMAN, Norman Clarence, Lt.-Col., R.C.O.C., (Tor. '10), Ordnance Mech. Engr., Dept. Nat. Defence, H.Q., M.D. No. 3, Kingston, Ont. (*Jr. 1911*) (*A.M. 1915*) (*M 1927*)

SHERRIN, Philip, (Feldkirch '90), Dept. of Mines, Ottawa, Ont. (*H*) 9, The Kelso, 17 McDonald St. (*A.M. 1919*)

♂SHERWOOD, Henry L., Major, R.C.E., (R.M.C., Kingston), Dist. Engr., Mil. Dist. No. 10, Fort Osborne Barracks, Winnipeg, Man. (*S. 1903*) (*A.M. 1907*)

SHERWOOD, Harris Mitchell, B.Sc., (Alta. '33), Metallurgist, Can. Industries Ltd., Brownsburg, Que. (*H*) 55–2nd St., Medicine Hat, Alta. (*S. 1935*)

SHERWOOD, Luman, (R.M.C., Kingston), Asst. Chief Engr., Dept. Rlys. and Canals, Ottawa, Ont. (*H*) 4 Regent St. (*S. 1900*) (*A.M. 1902*) (*M. 1908*)

SHIELDS, Stanley O., B.A.Sc., (Tor. '24), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 582 Bolivar St. (*S. 1920*) (*Jr. 1927*)

♂SHILLINGLAW, Walter H., Capt., 302 Russell St., Brandon, Man. (*S. 1887*) (*A.M. 1900*) (*M. 1908*) (*Life Member*)

SHIRLEY, Ernest Roxford, B.A., B.Sc., (Queen's '12), Elec. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 319 Frederick Ave. (*M. 1919*)

SHORT, H. Douglas, B.Sc., (Queen's '33), Address unknown. (*S. 1934*)

SHORTALL, John Desmond, B.Eng., (McGill '35), 5094 Cote St. Antoine Rd., Montreal, Que. (*S. 1935*)

SHORTEN, Christopher, B.Sc., (N.B. '29), Bell Telephone Co. of Canada, Montreal, Que. (*H*) 103–11th Ave., Lachine, Que. (*S. 1929*)

SHUPE, Stanley, B.A.Sc., (Tor. '14), City Engr., Kitchener, Ont. (*H*) 174 Queen St. (*A.M. 1920*) (*M. 1923*)

♂SHUTER, Edwin, 41 Raglan Ave., Toronto, Ont. (*Affil. 1933*)

SHUTTLEWORTH, Wilbur I., Engrg. Dept., City of Ottawa, City Hall, Ottawa, Ont. (*H*) 192 James St. (*Jr. 1932*) (*A.M. 1935*)

SIBLEY, Bertram C., 9 Victoria Row, Ireland Island, Bermuda. (*S. 1931*)

♂SILL, Albert Jennings, Lieut., Div. Engr., Constrn. Dept., C.N.R., Winnipeg, Man. (*M. 1917*)

SILLCOX, Lewis Ketcham, D.Sc., (Brussels '03), Vice-Pres., The New York Air Brake Co., Starbuck Ave., Watertown, N.Y. (*H*) 519 Washington St., Watertown, N.Y. (*M. 1926*)

SILLIMAN, Justus M., C.E., 53 Kensington Ave., Kingston, Ont. (*S 1907*) (*A.M. 1912*)

SILLITOE, Sydney, B.Sc., (Alta. '31), M.Sc., '35, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 3590 University St. (*S. 1930*)

SILLS, Hubert R., B.Sc., (Queen's '21), Can. Gen. Elec. Co. Ltd., 513 Gilmour St., Peterborough, Ont. (*S. 1921*) (*Jr. 1926*)

SILVER, Benjamin L., B.A., (McGill '13), B.Sc., '17, 719–8th Ave., Brooklyn, N.Y. (*A.M. 1920*)

SILVER, Ralph C., B.Sc., (McGill '27), M.Sc., Protection Engr., Can. Hydro Electric Corp., Ottawa, Ont. (*S. 1926*)

SIMMONS, Herbert John, B.Sc., General Steel Wares Ltd., London, Ont. (*H*) 377 Maitland St. (*S. 1928*)

SIMMONS, Thos. Lockwood, B.A., Dip.Eng., (N.B.), Chief Engr., Board of Railway Commissioners, Ottawa, Ont. (*H*) 92 James St. (*A.M. 1899*) (*M. 1923*)

SIMON, Robt. C., B.Sc., (McGill '26), Engrg. Dept., Imperial Oil Ltd., Montreal East, Que. (*H*) Apt. 5, 4451 St. Catherine St. E. (*S. 1925*) (*Jr. 1931*)

SIMONS, Finlay Wm., B.Sc., (Alta. '31), M.Sc., Northern Electric Co., 1261 Shearer St., Montreal, Que. (*H*) 3590 University St. (*S. 1931*)

SIMPKIN, Douglas Benjamin, B.Sc., (Alta. '22), Dftsman, Noranda Mines Ltd., Box 117, Noranda, Que. (*S. 1919*) (*Jr. 1927*) (*A.M. 1933*)

SIMPSON, Albert Edward, B.Sc., (McGill '23), Supt., Aerial Surveys Lab., Can. Airways, Ltd., 480 Lagauchetiere St. W., Montreal, Que. (*H*) 4866 Cote des Neiges Rd. (*A.M. 1933*)

SIMPSON, Philip, Sr. Dftsman., Handley Page Ltd., London, England. (*H*) 32 Crundale Ave., Kingsbury, London, N.W.9, England. (*A.M. 1923*)

♂SIMSON, D. C. Unwin, Major, Asst. Chief Engr., Can. Battlefields Memorial Comm., 35 Route d'Arras, St-Laurent Blangy (P. de C.), France. (*A.M. 1921*)

SINCLAIR, Archie B., B.Sc., (Man. '27), Chief Operator, Price Bros. & Co. Ltd., Kenogami, Que. (*H*) 18 Champlain St. (*S. 1927*) (*Jr. 1928*)

SINCLAIR, Geo., B.Sc., (Alta '33), M.Sc., '35, 12123–97th St., Edmonton, Alta. (*S. 1933*)

SINCLAIR, Malcolm, 108 Tupper Ave., Yorkton, Sask. (*A.M. 1917*)

SINNAMON, Alvin Wheeler, (Belfast T.C. '28), Factory Mgr., The Geometric Stamping Co., P.O. Box 345, Cleveland, Ohio. (*H*) 1872 Nela Ave., East Cleveland, Ohio. (*M. 1920*)

SINTON, James, Maritime Supt., Storms Contracting Co. Ltd., 49 Givens St., Toronto, Ont. (*H*) Memramcook, N.B. (*A.M. 1911*)

♂SIRRS, Robert Raymond, B.A.Sc., (Tor. '24), Cons. Engr., 394 Bank St., Ottawa, Ont. (*A.M. 1933*)

SISE, Paul Fleetford, B.Sc., (McGill '01), Pres., Northern Electric Co. Ltd., Rm. 1600, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 1266 Redpath Crescent. (*M. 1920*)

SISSON, Chas. E., (Tor. '05), Wks. Engr., Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 24 The Kingsway. (*M. 1919*)

SKELTON, C. Hastings, B.Sc., (McGill '30), Research Engr., Consolidated Paper Corp., Three Rivers, Que. (*H*) 379 Roslyn Ave., Westmount, Que. (*S. 1929*) (*Jr. 1935*)

SKOLFIELD, Herbert Nason, B.Sc., (C.E.), (Maine '14), Supt. and Chief Engr., Bar Harbor Airport, Ellsworth, Maine, U.S.A. (*A.M. 1919*)

SMAILL, William, B.Sc., (McGill '90), Chief Engr., Northern Constrn. Co. Ltd. and J. W. Stewart Ltd., 1115 Vancouver Block, Vancouver, B.C. (*M. 1918*)

SMALL, Frank S., B.Sc., (McGill '14), Churchill River Power Co., Island Falls, Via Flin Flon, Man. (*H*) 26 Ralph St., Ottawa, Ont. (*S. 1909*) (*A.M. 1917*) (*M. 1929*)

SMALLHORN, Edward Robert, B.Sc., (McGill '23), Managing Dir., Aerocrete Constrn. Co., 2033 Vendome Ave., Montreal, Que. (*S. 1923*) (*A.M. 1932*)

SMALLWOOD, Franklin, Chief Engr., Algoma Steel Corp'n., Ltd., Sault Ste. Marie, Ont. (*H*) 10 Forest Ave. (*M. 1921*)

†SMART, Russel S., B.A., M.E., (Tor. '13), Smart & Biggar, 609 Victoria Bldg., Ottawa, Ont. (*Affil. 1908*) (*A.M. 1911*) (*M. 1921*)

SMART, Valentine Irving, B.A., (Queen's '97), Deputy Minister, Dept. of Rlys. and Canals, Ottawa, Ont. (*M. 1917*)

SMITH, Adam W. Simpson, B.Sc., (McGill '23), 7 Edgewood Crescent, Toronto, Ont. (*S. 1921*)

SMITH, Albert Wilmot, B.Sc., (McGill '10), Asst. Engr., C.N.R., 601 C.N. Express Bldg., 355 McGill St., Montreal, Que. (*H*) 31 Crescent St., St. Lambert, Que. (*S. 1909*) (*A.M. 1913*) (*M. 1921*)

SMITH, Arthur, (*q*), M.A., (Laval), Q.L.S., 54 Bourlamaque Ave., Quebec, Que. (*A.M. 1898*) (*Life Member*)

SMITH, Arthur Albert, Chief Engr., Dept. of Public Highways, Ont. (*H*) 160 Stibbard St., Toronto 12, Ont. (*M. 1921*)

SMITH, A. J. E., B.A.Sc., (Tor. '35), James A. Wickett Co., Ltd., 16 Saulter St., Toronto, Ont. (*H*) 22 Madelaine Ave. (*S. 1935*)

SMITH, A. T. Eric, B.A., (Sask. '18), S.B., (M.I.T. '21), Res. Engr., Can. Industries Ltd., Windsor, Ont. (*H*) 20 Sunset Ave., Sandwich, Ont. (*A.M. 1929*)

SMITH, Carl C., B.Sc., (Queen's '32), Dftsman., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 187 Sanford Ave. N. (*S. 1928*) (*Jr. 1935*)

♂SMITH, Ernest, Asst. Dist. Engr., Dept. P.W., B.C., Court House, New Westminster, B.C. (*H*) 2562 Douglas Rd. (*A.M. 1922*)

SMITH, Eugene Lloyd, B.Sc., (Alta. '30), 9844–103rd St., Edmonton, Alta. (*S. 1930*)

SMITH, Frank Lawrence, Asst. Chief Dftsman., Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 46 Kensington Ave. (*A.M. 1921*)

SMITH, Fred. G., Bridge and Struct. Engr., Dept. P.W., Rm. 874, Hunter Bldg., Ottawa, Ont. (*H*) 146 Broadway Ave. (*A.M. 1918*)

SMITH, Geo. Barnett, B.Sc., (McGill '00), Dist. Supt., H.E.P.C. of Ont., Box 40, Belleville, Ont. (*H*) 252 Bridge St. E. (*M. 1927*)

♂SMITH, George Ellis, B.Sc., (N.B. '12), Chief Engr.'s Office, C.N.R., Moncton, N.B. (*A.M. 1921*)

SMITH, Gordon J., B.A., B.Sc., (C.E.), (Queen's), Sec.-Treas., Gen. Alumni Assoc.; Mgr., Employment Service Bureau, Queen's Univ., Kingston, Ont. (*H*) 266 Albert St. (*A.M. 1920*)

SMITH, Hamilton E., B.Sc., (McGill '25), Address unknown. (*S. 1925*) (*A.M. 1930*)

SMITH, H. Malcolm, B.A.Sc., (Tor. '32), Smith Mfg. Co., Ltd., 201 Front St. E., Toronto, Ont. (*H*) 308 Indian Rd. (*S. 1932*)

SMITH, James Norman, Supervising Engr., Pr. Plant, Glen Rd. Pr. House, City of Westmount, Westmount, Que. (*H*) 3072 The Boulevard. (*M. 1921*)

SMITH, Joseph A., B.A.Sc., Dist. Engr., Dept. Marine, Quebec, Que. (*H*) 331 Grande Allée. (*S. 1908*) (*A.M. 1910*)

G. †SMITH, Julian C., M.E., (Cornell), LL.D., (Queen's '23), LL.D., (McGill '28), Pres., Shawinigan Water and Power Co., 611 Power Bldg., Montreal, Que. (*H*) 619 Sydenham Ave., Westmount, Que. (*S. 1904*) (*A.M. 1904*) (*M. 1911*) (*Past-President*)

SMITH, Kenneth Harold, B.A., (Tor. '08), Vice-Pres. and Man'g. Dir., Can. Wineries Ltd., Rm. 608, 330 Bay St., Toronto 2, Ont. (*H*) 19 Errington Ave. (*Jr. 1912*) (*A.M. 1914*) (*M. 1920*)

SMITH, N. J. W., (R.M.C., Kingston), B.Eng., (McGill '32), Capt., Dept National Defence, Canadian Bldg., Ottawa, Ont. (*S. 1931*)

SMITH, Odric H., B.Eng., (McGill '35), Dom. Textile Co. Ltd., Montreal, Que. (*H*) 11 Melbourne Ave., Westmount, Que. (*S. 1935*)

SMITH, Owen L., Glovertown, Nfld. (*S. 1935*)

♂SMITH, Paul Moody, Mgr., P. M. Smith Constrn., Co., Vancouver, B.C. (*H*) 3241 Point Grey Rd. (*A.M. 1920*)

SMITH, Ralph Rollann, River Hebert, Cumb. Co., N.S. (*S. 1931*)

SMITH, Robert Melville, B.Sc., (Queen's '14), Deputy Minister, Dept Public Highways, Ontario, Parliament Bldgs., Toronto, Ont. (*A.M. 1921*)

SMITH, Walter Alex., B.Sc., (Alta. '33), 222–3rd Ave., N.E., Calgary, Alta. (*S. 1932*) (*Jr. 1935*)

SMITH, Wilfrid Ewart, B.Sc., (N.B. '35), 852 George St., Fredericton, N.B. (*S. 1934*)

P. †SMITH, William Nelson, M.E., (Cornell), Report Engr., E. M. Gilbert Engrg. Corpn., 412 Washington St., Reading, Pa. (*H*) 2423 Fairview St. (*M. 1919*)

♂SMITH, Wm. Raywood, County Bldgs., London, Ont. (*H*) R.R. 3, Lambeth, Ont. (*A.M. 1918*)

SMITH, W. Stanley, 112 St. George St., Toronto, Ont. (*H*) 4 Thomas St., St. Catharines, Ont. (*S. 1931*)

SMITHER, W. J., B.A.Sc., (Tor. '05), Assoc. Prof. of Struct. Engrg., Univ. of Toronto, Toronto, Ont. (*H*) 35 Wilberton Rd. (*A.M. 1914*) (*M. 1925*)

♂SMYTH, Charles McDowall, Major, M.M., Gen. Supt., Eastern Light and Power Co. Ltd., Sydney, N.S. (*H*) 46 Lorway Ave. (*Jr. 1920*) (*A.M. 1921*) (*M. 1931*) (*Member of Council, E.I.C.*)

♂SMYTHE, R. Eric, Col., D.S.O., M.C., B.A.Sc., (Tor. '26), Dir., Technical Service Council, 2 Grosvenor St., Toronto, Ont. (*H*) 38 Duplex Ave. (*Jr. 1920*) (*A.M. 1929*) (*M. 1935*)

♂SMYTHIES, Reginald Eric, Lieut., R.N.V.R., Pres., Lincoln Electric Co. of Canada, Ltd., 65 Bellwoods Ave., Toronto 3, Ont. (*H*) 125 Alexandra Blvd. (*A.M. 1924*) (*M. 1926*)

SNIDER, Arthur Melville, B.A.Sc., (Tor. '17), Gen. Mgr., Sunshine Waterloo Co., Ltd., Waterloo, Ont. (*H*) 115 Allen St. W. (*S. 1917*) (*Jr. 1918*) (*A.M. 1922*)

♂SNYDER, Frederic Antes, Col., D.S.M., 105 Carnegie Ave., East Orange, N.J. (*M. 1915*)

SOLES, Wm. E., B.Sc., (Queen's '35), Rock Island, Stanstead Co., Que. (*S. 1935*)

SOUBA, Wm. Henry, M.E., (Minn. '09), 4601 Edina Blvd., Country Club Dist., Minneapolis, Minn., U.S.A. (*M. 1922*)

SOUTHMAYD, C. G., Jr., B.A.Sc., (Tor. '32), Gen. Supt., J. Fleury's Sons, Ltd., Box 241, Aurora, Ont. (*S. 1932*)

SOZANSKY, John, B.Sc., (McGill '29), National Research Council, Ottawa, Ont. (*S. 1928*)

SPARK, Harry S., Asst. Engr., Harbour Commissioners of Montreal, Montreal, Que. (*H*) Apt. 21, 223 Melville Ave., Westmount, Que. (*A.M. 1922*)

SPARKS, Wm. H., B.A.Sc., (B.C. '35), 2506 Scott St., Vancouver, B.C. (*S. 1928*) (*Jr. 1934*)

SPENCE, G. D., B.Sc., (N.S.T.C. '32), St. Croix, Hants Co., N.S. (*S. 1931*)

SPENCE, John Jas., (Tor. '09), Lecturer, Faculty of Applied Science, Univ. of Toronto, Toronto, Ont. (*H*) 162 Glencairn Ave. (*A.M. 1926*)

♂SPENCER, Henry Cyril, Northern Electric Co. Ltd., Montreal, Que. (*H*) 4323 Beaconsfield Ave. (*A.M. 1935*)

SPENCER, Raymond A., B.Sc., (Vermont '08), Contracting Engr., Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 300 Victoria Rd. (*M. 1927*)

♂SPENCER, Roy Aubrey, Major, M.C. and Bar, B.Sc., M.Sc., (McGill), Prof of C.E., Univ. of Saskatchewan, Saskatoon, Sask. (*H*) 915 Temperance St (*S. 1907*) (*Jr. 1913*) (*A.M. 1919*)

SPENCER, Walter Hutchins, B.Sc., (McGill '09), Asst. Secry., Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 646 Belmont Ave., Westmount, Que. (*A.M. 1927*)

SPOTTON, John Greer, B.A.Sc., (Tor. '22), Sales Engr., Delaney & Pettit, Ltd., 133 Jefferson Ave., Toronto, Ont. (*H*) 123 Pearson Ave. (*S. 1920*) (*Jr. 1924*) (*A.M. 1934*)

SPRATT, Maynard James, B.Sc., (McGill '22), Chief Engr., Sask. Pool Elevators Ltd., Regina, Sask. (*H*) 2302 Elphinstone St. (*S. 1921*) (*A.M 1927*)

♂SPRENGER, A. Reginald, Lt.-Col., (R.M.C., Sandhurst '97), (C.G.I.), Pres., Filmite Co. Reg'd., 3579 Clarke St., Montreal, Que. (*H*) 4342 Beaconsfield Ave. (*S. 1906*) (*A.M. 1908*) (*M. 1919*)

SPRIGGS, Robert H., B.Sc., (McGill '24), The Bell Telephone Co. of Canada, Ltd., 320 Bay St., Toronto, Ont. (*H*) 552 Briar Hill Ave. (*S. 1920*) (*Jr. 1929*)

P. †SPROULE, Gordon St. G., M.Sc., (McGill '09), Assoc. Prof. of Metallurgy, McGill Univ., Montreal, Que. (*H*) 39 Thornhill Ave., Westmount, Que (*S. 1904*) (*Jr. 1912*) (*A.M. 1920*) (*M. 1932*)

SPROULE, John Emdon, B.Sc., (McGill '16), Mgr., Can. Hoosier Engrg. Co. Ltd., 41 Cote St. Paul Rd., Montreal, Que. (*H*) 4275 Cote St Luc Rd. (*A.M. 1926*)

STADLER, John, Industrial Engr., 1117 St. Catherine St. W., Montreal, Que. (*H*) 4334 Westmount Ave., Westmount, Que. (*M. 1921*)

STADLER, John Chas., 4334 Westmount Ave., Westmount, Que. (*S. 1927*)

♂STAIRS, Denis, B.E., (Dalhousie '09), Montreal Engineering Co., 244 St. James St., Montreal, Que. (*H*) 841 Lexington Ave. (*M. 1930*)

♂STAIRS, Gordon S., Lieut., B.Sc., (N.S.T.C. '11), Wolfville, N.S. (*Jr. 1914*) (*A.M.* 1919) (*M. 1928*)

STAMFORD, Wm. Leonard, B.A.Sc., (Tor. '09), Acting Agent, Dept. of Marine, Prince Rupert, B.C. (*A.M. 1916*)

STANFIELD, John Y., (R.M.C. Kingston), B.Sc., (N.S.T.C. '33), Consolidated Paper Corpn., Shawinigan Falls, Que. (*H*) 61 Maple Ave. (*S. 1932*)

STANLEY, James Norman, B.Sc., M.A., Beechwood Ave., R.R. 2, York Mills, Ont. (*S. 1908*) (*A.M. 1912*)

STANLEY, Thos. Douglas, B.Sc., (Alta '32), M.Eng., (McGill '33), Asst. Engr., Calgary Power Co. Ltd., Calgary, Alta. (*H*) High River, Alta. (*S. 1932*)

P. †STANSFIELD, Alfred, D.Sc., (London), Chairman, Dept. Met. Engrg., and Prof. of Metallurgy, Chemistry Bldg., McGill University, Montreal, Que. (*H*) 3182 Westmount Blvd. (*Affil. 1904*) (*M. 1918*)

†STANSFIELD, Edgar, M.Sc., Chief Chem. Engr., Research Council of Alberta. Address: Univ. of Alberta, Edmonton, Alta. (*H*) 11009–88th Ave. (*M. 1918*)

STARKEY, J. Leonard, 4559 Madison Ave., Montreal, Que. (*S. 1933*)

♂STARLEY, Bernard, Engr. Asst., Birmingham Corp., Council House, Birmingham, England. (*H*) 23 Northumberland Rd., Leamington Spa, Warwickshire, England. (*A.M. 1926*)

♂STAVERT, R. Ewart, B.Sc., (McGill '14), Asst. to Pres., Cons. Mining and Smelting Co. of Can., 215 St. James St., Montreal, Que. (*H*) 30 Richelieu Pl. (*Jr. 1919*) (*A.M. 1926*)

STEAD, Geoffrey, B.A., C.E., (N.B. '92), Dist. Engr., Dept. P.W., Canada, Box 1417, Saint John, N.B. (*H*) 257 Princess St. (*A.M. 1900*) (*M. 1921*)

♂ꝥ †STEDMAN, Ernest Walter, O.B.E., (A.R.C.S., London), Group-Capt., R.C.A.F., Chief Aero. Engr., Dept. of National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 1st Ave., McKellar. (*M. 1921*) (*Member of Council, E.I.C.*)

♂STEEL, Francis M., Lt.-Col., D.S.O., Petroleum Engr., Dept. Inter., 503 Public Bldg., Calgary, Alta. (*H*) 515 Sunderland Ave. (*M. 1920*) (*Member of Council, E.I.C.*)

STEENBUCH, Haralo L., B.A., Engrg. Dept., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*A.M. 1912*)

ꝥ STEEVES, Beverley Hall, B.Sc., (McGill '23), Vacuum Tube Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 5395 Duquette Ave. (*A.M. 1929*)

STEEVES, Cecil M., B.Sc., (Man. '27), Engrg. Dept., Can. and General Finance Co., 25 King St. W., Toronto, Ont. (*H*) 41 Kennedy Ave. (*S. 1927*)

STEEVES, John Trites R., B.Sc., (McGill '12), Asst. Factory Engr., Imperial Tobacco Co. of Can., Ltd., 3810 St. Antoine St., Montreal, Que. (*H*) 4151 Hampton Ave. (*S. 1912*) (*A.M. 1917*)

STEEVES, S. M., B.Sc., (Man. '25), Topographical Engr., Dept. Mines, Victoria Memorial Museum, Ottawa, Ont. (*H*) 36 Renfrew Ave. (*S. 1924*) (*A.M. 1930*)

♂STEIN, Chas. R. S., Major, R.C.E., Asst. Dir. of Engr. Services, H.Q., Dept. National Defence, Ottawa, Ont. (*A.M. 1925*)

STEINMAN, David Barnard, B.S., (City of N.Y. '06), C.E. and A.M., (Columbia '09), Ph.D.'10., Cons. Engr., Robinson & Steinman, 117 Liberty St., New York, N.Y. (*H*) 305 Riverside Dr. (*M. 1929*)

STEINMAYER, Otto C., B.S., (Illinois '02), Timber Preservation Supt., Canada Creosoting Co. Ltd., 423 Canada Cement Bldg., Montreal, Que. (*H*) 512 Prince Albert Ave., Westmount, Que. (*M. 1925*)

STENBOL, Carl, Mech. Supt., Algoma Steel Corp'n., Sault Ste. Marie, Ont. (*H*) 167 Simpson St. (*M. 1921*)

♂STENHOUSE, Ronald H., Div. Engr., C.P.R., Box 447, Farnham, Que. (*Jr. 1920*) (*A.M. 1922*)

♂STEPHEN, Charles, Engr. Lt.-Cmdr., Technical Adviser, R.C.M. Police, Larocque Bldg., Ottawa, Ont. (*A.M. 1917*)

STEPHEN, Gordon Robt., B.Sc., (McGill '23), Engr., Fraser, Brace Ltd., Power Bldg., Montreal, Que. (*H*) 4546 Kensington Ave. (*A.M. 1933*)

STEPHENS, Donald McGregor, B.Sc., (Man. '31), Tech. Dftsman, Dept Mines and Nat. Resources, 346 Legislative Bldg., Winnipeg, Man. (*H*) Ste. 18, Willingdon Apts., Kennedy St. (*Jr. 1934*) (*A.M. 1935*)

♂STEPHENS, George Leslie, Engr. Cmdr., R.C.N., Chief Engr., H.M.C. Dockyard, Dept. National Defence, Esquimalt, B.C. (*A.M. 1919*) (*M. 1926*)

♂STEPHENS, John, Lieut., D.Sc., (N.B. '27), Prof., Mech. Engrg., University of N.B., P.O. Box 512, Fredericton, N.B. (*M. 1924*)

♂STEPHENSON, George, Mtce. Engr., E. B. Eddy Co. Ltd., Hull, Que. (*H*) 236-B, Linden Terrace, Ottawa, Ont. (*A.M. 1931*)

♂STEPHENSON, Geo. Eloin, Lieut., B.A.Sc., (Tor. '20), County Engr. and Rd Supt., Bruce County, Box 398, Walkerton, Ont. (*S. 1916*) (*Jr. 1921*) (*A.M. 1923*)

STEPHENSON, John, Chief Engr., Can. Atlas Steels Ltd., Welland, Ont. (*H*) Box 117, Queen St., Sydney Mines, N.S. (*A.M. 1921*)

STEPHENSON, J. G., Elec. Engr., Teck Hughes Gold Mines, Kirkland Lake, Ont. (*S. 1923*)

STERNS, Frank E., M.Sc., (McGill '03), Cons. Engr., 9 Midland St., St. Catharines, Ont. (*A.M. 1907*) (*M. 1926*)

STERNS, Laurence, B.Sc., (N.S.T.C. '24), Asst. Plant Engr., Can. International Paper Co., Three Rivers, Que. (*H*) 125 Bonaventure St. (*S. 1923*) (*Jr. 1925*) (*A.M. 1929*)

♂STEVENS, Frederick, M.M., Squad Foreman, Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 98 Windermere Rd. (*A.M. 1923*)

STEVENS, Hugh E., Headquarters, B.C. (*A.M. 1917*)

STEVENS, Robt. Herbert, Waterworks Dept., City of Edmonton, Civic Block, Edmonton, Alta. (*H*) 9406–96th-A St. (*A.M. 1927*)

STEVENS, Robt. L., B.Sc., (Alta' 35), 9827–85th Ave., Edmonton, Alta. (*S. 1935*)

STEVENSON, Chas. L., B.Sc., (N.B. '34), 19 Seely St., Saint John, N.B. (*S. 1934*)

♂STEVENSON, William F., Lieut., Supt., Sterling Collieries, Ltd., Sterco, Alta. (*A.M. 1910*)

STEWART, Alexander Forrester, B.A., (Dalhousie), 28 South St., Halifax, N.S. (*M. 1897*) (*Life Member*)

STEWART, Donald, B.Sc., (McGill '25), Div. Equipment Engr., The Bell Telephone Co. of Canada, Ltd., 87 Ontario St. W., Montreal, Que. (*H*) 15 Julien Ave., Pointe Claire, Que. (*S. 1924*) (*Jr. 1927*) (*A.M. 1933*)

STEWART, Donald Laughlin, B.Sc., (McGill '24), Engr., The Bell Telephone Co. of Canada, Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4536 Coolbrook Ave. (*S. 1922*) (*A.M. 1927*)

STEWART, Duncan E., B.Sc., (Queen's '33), Waba, Ont. (*S. 1933*)

STEWART, Fred. Choate, Asst. Engr., Vancouver Water Dist., Vancouver, B.C. (*H*) 2748 Dundas St. (*M. 1934*)

STEWART, Graeme M., B.A., (Tor. '00), Surveys Dept., C.N.R., Express Bldg., C.N.R., Toronto, Ont. (*H*) 31 Manor Rd. W. (*A.M. 1907*)

STEWART, John R., B.Sc., (McGill '27), Service Engr., Can. Liquid Air Co. Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 1490 Fort St. (*S. 1925*) (*Jr. 1934*)

STEWART, John Robertson, Town Engr., Box 597, Renfrew, Ont. (*H*) 197 Argyle St. (*A.M. 1921*)

STEWART, L. B., B.Sc., (McGill '27), Shawinigan Water and Power Co., Shawinigan Falls, Que. (*S. 1925*) (*Jr. 1932*)

♂STEWART, Malcolm Davidson, B.A.Sc., (Tor. '22), Seigniory Club Community Assoc. Ltd., Seigniory Club, P.O. Box 43, Montebello, Que. (*S. 1919*) (*Jr. 1924*) (*A.M. 1929*)

STEWART, Murray Alex., (Tor. '05), Principal Asst. Engr., Dept. Wks., City Hall, Toronto, Ont. (*H*) 282 Glencairn Ave. (*A.M. 1912*)

STEWART, Robert Bruce, B.Sc., (McGill '10), Pres. and Chief Engr., I. Matheson & Co., Ltd., New Glasgow, N.S. (*S. 1909*) (*Jr. 1913*) (*A.M. 1916*) (*M. 1918*)

STEWART, R. Meldrum, M.A., (Tor. '03), Director, Dominion Observatory, Ottawa, Ont. (*M. 1924*)

STEWART, Ross Oliff, B.A.Sc., (Tor. '11), Asst. Engr., C.N.R., 6th Floor, Can. Express Bldg., Montreal, Que. (*H*) 101 Dobie Ave., Town of Mount Royal, Que. (*A.M. 1920*)

STEWART, Walter D., B.Sc., (Queen's '33), Apt. 4, 1483 Atwater Ave., Montreal, Que. (*S. 1933*)

STEWART, Wm. F., B.Sc., (McGill '26), Can. Gen. Elec. Co., Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 4385 Western Ave. (*S. 1923*) (*Jr. 1929*)

STEWART, Wm. Lewis Reford, (R.M.C., Kingston '20), Managing Dir., Stewart Constrn. Co. Ltd., P.O. Box 735, Sherbrooke, Que. (*H*) 98 Quebec St. (*S. 1920*) (*A.M. 1928*)

STILES, John A., O.B.E., B.A.Sc., (Tor. '08), Chief Executive Commr., Boy Scouts Assoc., 306 Metcalfe St., Ottawa, Ont. (*H*) 2 Seneca St. (*A.M. 1913*) (*M. 1916*)

STINSON, John Nichols, B.Sc., (Queen's '14), Sr. Asst. Engr., Dom. Parks Br., Dept. Interior, Ottawa, Ont. (*S. 1912*) (*Jr. 1917*) (*A.M. 1919*)

STIRLING, Grote, The Hon., Private Practice, Kelowna, B.C. (*M. 1927*)

♂STIRLING, John Bertram, B.A., B.Sc., (Queen's '11), Engr., E. G. M. Cape & Co., 960 New Birks Bldg., Montreal, Que. (*H*) 1612 Selkirk Ave. (*M. 1934*)

STIRLING, L. Brodie, B.Sc., (McGill '24), Asst. Engr., Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 120 Cedar Ave. (*S. 1921*) (*Jr. 1929*)

ST. JACQUES, Gustave F., 425 St. Joseph Blvd., Montreal, Que. (*S. 1935*)

ST. LAURENT, Jos. Emile, C.E., (Ecole Polytech., Montreal '09), Q.L.S., Dist. Engr., Dept. P.W., Canada, 844 Hunter Bldg., Ottawa, Ont. (*H*) 431 Daly Ave. (*M. 1922*)

STOBBART, Wm. Morley, Asst. Engr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 33 Drayton Ave., Pointe Claire, Que. (*A.M. 1935*)

STOCKETT, Lewis, 245 Vancouver Hotel, Vancouver, B.C. (*M. 1916*)

STOCKTON, Robert Summers, E.M., (Colorado), Craigantler Ranch, Thompson Falls, Montana, U.S.A. (*M. 1918*)

STODART, James, Waterworks Engr., City of Hamilton, Ont. (*H*) 10 Stanley Ave. (*A.M. 1924*) (*M. 1929*)

♂STOKES, Percy F., Chief Dftsman, Industrial Dept., Can. Vickers, Ltd., Montreal, Que. (*H*) 4477 Notre Dame St. E. (*A.M. 1925*)

†STONE, Ernest A., Ma.E., (McGill '91), 177 Victoria Rd., Walkerville, Ont. (*S. 1888*) (*A.M. 1895*) (*M. 1906*) (*Life Member*)

STOREY, Gilbert Calder, B.A.Sc., (Tor. '15), Secy. and Mgr., Water Commrs., City Hall, Windsor, Ont. (*H*) 372 Eastlawn Blvd., Riverside, Ont. (*A.M. 1931*)

STOREY, Thos. E., B.Sc., (Man. '28), Ch. Oper., (Slave Falls), City of Winnipeg Hydro-Elec. System. Address: Pointe du Bois, Man. (*S. 1926*) (*Jr. 1933*)

†STORRIE, William, Cons. Engr., Gore, Nasmith & Storrie, Charles-Bay Bldg., 1130 Bay St., Toronto, Ont. (*H*) 31 Alexandra Blvd. (*A.M. 1910*) (*M. 1917*)

STORY, Geo. L., B.Sc., (Alta' 32), 883 Ossington Ave., Toronto, Ont. (*S. 1930*)

STOTT, Joseph Duncan, Engr., Power Engineering Co., 107 Craig St. W., Montreal, Que. (*A.M. 1921*)

♂STOWE, Geo. Norman, Lieut., 1080 Burris St., Burnaby, New Westminster, B.C. (*A.M. 1920*)

♂STRATHY, R. L. A., Lieut., B.Sc., (McGill '14), 481 Prince Albert Ave., Westmount, Que. (*Jr. 1921*) (*A.M. 1922*)

STRATTON, Fred. Stephen, B.Sc., (Man. '30), Chloride Electric Storage Co. Ltd., 137 Victoria St., London, S.W.2. (*H*) 2 Donovan Court, 97 Drayton Gardens, London, S.W.10. (*S. 1928*)

STRATTON, Leslie Robertson, B.Sc., (N.B. '30), 28 Exmouth St., Saint John, N.B. (*S. 1930*)

STRATTON, W. Donald Geo., B.Sc., (N.B. '29), 28 Exmouth St., Saint John, N.B. (*S. 1929*)

STRAUSS, Joseph Baerman, D.Sc., C.E., (Cin.), Pres. Strauss Engineering Corp., 307 N. Michigan Ave., Chicago, Ill. (*A.M. 1909*) (*M. 1921*)

STREET, James Cunard, B.A.Sc., (Tor. '11), O.L.S., Sr. Asst. Engr., Welland Ship Canal, Box 185, Welland, Ont. (*H*) 181 North Main St. (*S. 1909*) (*Jr. 1913*) (*A.M. 1914*) (*M. 1921*)

†STRICKLAND, T. P., M.Sc., (McGill '99), Chief Engr., Melbourne and Metropolitan Tramways Bd., 673 Bourke St., Melbourne, Australia. (*S. 1898*) (*M. 1910*)

STRIOWSKI, John Ben., B.Sc., (Man. '29), 257 Beverley St., Winnipeg, Man. (*S. 1927*) (*Jr. 1935*)

♂STROME, Ivan Roy, Lieut., B.A.Sc., (Tor. '14), Dom. Water Power and Hydrometric Bureau, Dept. Interior, Ottawa, Ont. (*H*) 127 Metcalfe St (*A.M. 1920*)

STRONG, Robert Ambrose, B.Sc., (Illinois '15), Engr., Dept. Mines, Mines Br., 552 Booth St., Ottawa, Ont. (*H*) 587 MacLaren St. (*A.M. 1921*)

STRONG, Robt. Lloyd, B.A.Sc., (Tor. '31), Can. Industries, Ltd., Brownsburg, Que. (*H*) Perth, Ont. (*S. 1932*)

♂STUART, Harold Brownlee, Major, B.A.Sc., (Tor. '09), Field Engr., Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 17 Highcliffe Ave. (*A.M. 1920*) (*M. 1935*)

STUART, H. Black, B.A.Sc., (McGill '92), Private Practice, Cons. and Appraisal Engr., H. B. Stuart & Co., 1 Toronto St., Toronto, Ont. (*H*) 85 Dawlish Ave. (*S. 1888*) (*A.M. 1898*)

♂STUART, Wm. Grey, Capt., White Eagle Mines, North West Minerals, Cameron Bay, N.W.T. (*H*) 10335–117th St., Edmonton, Alta. (*A.M. 1927*)

♂STUART, Wm. Henry, Supt. of Facilities, C.N.R., 360 McGill St., Montreal, Que. (*A.M. 1919*) (*M. 1932*)

STURDEE, Chas. Parker, B.Eng., (McGill '34), Dftsman., Imperial Oil Ltd., P.O. Box 1510, Montreal, Que. (*H*) 106–14th Ave., Pointe-aux-Trembles, Que. (*S. 1934*)

SUDDEN, E. A., B.A.Sc., (Tor. '26), 343 High Park Ave., Toronto, Ont. (*S. 1926*) (*Jr. 1928*)

SULLIVAN, Arthur Wm., Q.L.S., Private Practice and City Engr., P.O. Box 124, Valleyfield, Que. (*S. 1909*) (*Jr. 1914*) (*A.M. 1920*)

SULLIVAN, John G., C.E., (Cornell '88), 316 Nanton Bldg., Winnipeg, Man. (*H*) 207 Harvard Ave. (*M. 1900*) (*Past-President*)

SULLIVAN, Wm. Henry, (R.M.C., Kingston '92), 11 Welland Ave., St. Catharines, Ont. (*A.M. 1899*) (*M. 1920*) (*Life Member*)

†SURVEYER, ARTHUR, B.A., B.A.Sc., C.E., D.Eng., Cons. Engr., Arthur Surveyer & Co., 1003 Dom. Square Bldg., Montreal, Que. (*H*) Acadia Apts., 1227 Sherbrooke St. W. (*S. 1899*) (*A.M. 1907*) (*M. 1912*) (*Past-President*)

SUTCLIFFE, HOMER W., (Tor. '07), Pres., Sutcliffe Co., Ltd., New Liskeard, Ont. (*S. 1908*) (*A.M. 1913*)

SUTHERLAND, ALEXANDER, B.Sc., (Acadia '11), Prof. and Dean of Engrg., Acadia Univ., Wolfville, N.S. (*A.M. 1920*)

SUTHERLAND, D. B., B.Sc., Guysboro Mines Ltd., Goldenville, N.S. (*S. 1932*)

SUTHERLAND, DUNCAN G., Mgr., Elec. Sales, Winnipeg Electric Co., Winnipeg, Man. (*H*) 1012 Jessie Ave. (*A.M. 1922*)

SUTHERLAND, GEO. MACKENZIE, B.Sc., (N.S.T.C. '25), Dftsman., Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) 43 Quebec St. (*S. 1924*) (*A.M. 1931*)

SUTHERLAND, J. GORDON, B.Sc., (N.S.T.C. '35), St. Peter's Bay, P.E.I. (*S. 1935*)

♂SUTHERLAND, J. R. S., Lieut., 4 Greenhill Terrace, Edinburgh, Scotland. (*A.M. 1911*)

♂SUTHERLAND, L. H. D., Lieut., B.Sc., (McGill '09), Pres., Sutherland Constrn. Co., 1440 St. Catherine St. W., Montreal, Que. (*H*) 11 Richelieu Pl. (*M. 1926*)

♂SUTHERLAND, RONALD DOUGLAS, Major, M.C., (R.M.C., Kingston '12), B.Sc., (McGill '14), Merchandise Mgr., Can. Westinghouse Co. Ltd., 400 McGill St., Montreal, Que. (*H*) 4615 Cedar Cres. (*A.M. 1920*)

SUTHERLAND, WM. C., B.Sc., (N.S.T.C. '33), P.O. Box 846, Westville, Pictou Co., N.S. (*S. 1931*)

SUTHERLAND, WM. H., B.A.Sc., (Tor. '03), Chief Engr., C. J. Dryden Co., Ltd., 1434 St. Catherine St. W., Montreal, Que. (*H*) 28 Arlington Ave., Westmount, Que. (*A.M. 1910*) (*M. 1922*)

SVARICH, J. P., B.Sc., (Alta. '29), Spedden, Alta. (*S. 1927*) (*Jr. 1934*)

SWABEY, HAROLD WM. BIRCHFIELD, Capt., Sec., Donald-Hunt Ltd., 1181 Guy St., Montreal, Que. (*H*) Apt. 308, 52 Academy Rd., Westmount, Que. (*A.M. 1910*) (*M. 1919*)

♂SWAN, HAMILTON LINDSAY, Lieut., Dist. Engr., Dept. P.W., B.C. Parliament Bldgs., Victoria, B.C. (*H*) 2474 McNeill Ave., Oak Bay, B.C. (*A.M. 1915*) (*M. 1928*) (*Member of Council, E.I.C.*)

SWAN, RUSSELL G., B.A.Sc., (Tor. '09), C.E., Engr., Water Resources Dept., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 6 Campbell Ave., Montreal West, Que. (*S. 1907*) (*A.M. 1913*)

♂SWAN, WM. GEO., Major, D.S.O., C. de G., B.A.Sc., (Tor. '06), Cons. Engr., 814 Birks Bldg., Vancouver, B.C. (*H*) 1596 Balfour Ave. (*S. 1906*) (*A.M. 1910*) (*M. 1919*)

SWARTZ, JOS. NORMAN, B.Eng., (McGill '34), Pulp and Paper Research Institute, 3420 University St., Montreal, Que. (*H*) 1401 Ford St., Fort William, Ont. (*S. 1934*)

SWEEZEY, ROBT. OLIVER, B.Sc., (Queen's), Cons. Engr., Newman, Sweezey & Co., 210 St. James St. W., Montreal, Que. (*S. 1907*) (*A.M. 1909*) (*M. 1916*)

SWIFT, JOHN WM., B.Eng., (McGill '35), Aluminum Co. of Canada, Arvida, Que. (*H*) 642 Belmont Ave., Westmount, Que. (*S. 1933*)

♂SWINNERTON, AYLMER ABERFFRAW, B.A.Sc., (Tor. '19), Chem. Engr., Fuel Research Labs., Mines, Dept. Mines, Ottawa, Ont. (*H*) 19 Lakeside Terrace. (*A.M. 1924*)

SYKES, SAMUEL H., 1215–14th Ave. W., Vancouver, B.C. (*M. 1887*) (*Life Member*)

SYMES, CYRIL BARRON, City Engr., City Hall, Fort William, Ont. (*H*) 410 South Norah St. (*A.M. 1922*)

TABOR, AUBREY CLIFTON, B.Sc., (N.B. '97), 770 George St., Fredericton, N.B. (*A.M. 1922*)

TACHÉ, JOSEPH C., Address unknown. (*M. 1903*) (*Life Member*)

♂TACKABERRY, STANLEY GIBSON, Sqdn. Ldr., B.A.Sc., (Tor. '14), Staff Officer Equipment, R.C.A.F., Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 1087 Carling Ave. (*A.M. 1920*)

TAIT, DOUGLAS L., B.A.Sc., (Tor. '32), Univ. of Western Ontario, 396 Victoria St., London, Ont. (*S. 1932*)

TAIT, GORDON EWING, B.Sc., (McGill '30), Foundry Engr., Dom. Engineering Co., Ltd., P.O. Box 3150, Montreal, Que. (*H*) Apt. 5, 5530 Cote St. Luc Rd. (*S. 1930*)

TAIT, IRVING R., B.Sc., (McGill '13), Asst. Chief Engr., Can. Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4378 Harvard Ave. (*A.M. 1921*)

TAIT, ISAAC JOS., Cons. Engr., and Marine Surveyor, 486 St. John St., Montreal, Que. (*H*) Apt. 16, 2054 Sherbrooke St. W. (*A.M. 1918*) (*M. 1923*)

TAIT, J. L. M., Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 113 Birch Ave., St. Lambert, Que. (*A.M. 1922*)

TALBOT, CHARLES, County Engr., Middlesex County, London, Ont. (*H*) 26 Cynthia St. (*A.M. 1921*)

TALMAN, STEPHEN G., Dftsman., Water Distribution Section, City of Toronto, 511 Richmond St. W., Toronto 2, Ont. (*H*) 88 Delaware Ave. (*A.M. 1914*)

TANNENBAUM, J., B.Eng., (McGill '34), 5344 Jeanne Mance St., Montreal, Que. (*S. 1934*)

G.TAPLEY, ALEXANDER G., Asst. Engr., D.P.W., Canada, Halifax, N.S. (*H*) 65 Walnut St. (*S. 1904*) (*A.M. 1909*)

TAPLEY, DONALD GORDON, B.Sc., (N.S.T.C. '34), 65 Walnut St., Halifax, N.S. (*S. 1934*)

TAPLEY, FREDERICK B., Engr., Mtce. of Way, C.N.R., Winnipeg, Man. (*H*) 198 Montrose St. (*A.M. 1910*) (*M. 1919*)

TARR, FRANCIS G. A., B.A.Sc., (B.C. '26), 372 Mark St., Peterborough, Ont. (*S. 1926*)

TASSÉ, YVON-ROMA, B.A.Sc., (Ecole Polytech. '35), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 4683 Christophe Colomb, Montreal, Que. (*S. 1934*)

TASSIE, ROBT. WILSON, B.E., (Adelaide '07), M.E., (Cornell '09), Mgr., Venezuela Power Co. Ltd., Apartado 146, Maracaibo, Venezuela, S.A. (*M. 1929*)

♂TATE, HARRY WM., Major, B.A.Sc., (Tor. '10), O.L.S., D.L.S., Asst. Mgr., Toronto Transportation Comm'n., Public Utilities Bldg., Toronto, Ont. (*H*) 14 Glengowan Rd. (*S. 1909*) (*A.M. 1913*)

TATHAM, W. C., B.Eng., (McGill '35), 3647 University St., Montreal, Que. (*H*) Elora, Ont. (*S. 1935*)

♂TAUNTON, ARTHUR J. S., Major, D.S.O., B.Sc., (Man. '12), D.P.W., Canada, Winnipeg, Man. (*H*) 930 Somerset Ave. (*S. 1909*) (*A.M. 1914*)

TAYLOR, A. J. T., 4 Cleveland Square, St. James, London, S.W.1. (*M. 1925*)

TAYLOR, ANDREW, B.Sc., (Man. '31), M.L.S., D.L.S., Tech. Dftsman., Dept. Mines and Natural Resources, 346 Legislative Bldg., Winnipeg, Man. (*H*) 346 Union Ave. (*Jr. 1934*) (*A.M. 1934*)

TAYLOR, BRUCE S., B.Sc., (Queen's '29), Traffic Dept., Bell Telephone Co. of Canada, Montreal, Que. (*S. 1929*)

TAYLOR, FRANK, Rt. of Way and Tax Agent, C.P.R., Montreal, Que. (*H*) 509 Roslyn Ave., Westmount, Que. (*S. 1898*) (*A.M. 1903*) (*M. 1910*)

♂TAYLOR, FRANK H., Capt., M.C., B.A.Sc., (Tor. '21), Transmission Engr., Lehigh Structural Steel Co., Rm. 1143, 17 Battery Pl., New York, N.Y. (*H*) 3532–168th St., Flushing, L.I. (*S. 1920*) (*A.M. 1925*)

TAYLOR, GILBERT FERGUSON, Engr., Bridges and Structures, City of Ottawa, Transportation Bldg., Ottawa, Ont. (*A.M. 1924*)

♂TAYLOR, GORDON R., Major, Grafton, Ont. (*Jr. 1912*) (*A.M. 1919*)

TAYLOR, HOWARD SMITH, B.C.E., (Maine '04), 238 Grove Ave., Sarasota, Florida. (*M. 1923*)

TAYLOR, JAS. LAWRENCE, Barriefield, Ont. (*S. 1934*)

TAYLOR, MORLEY GLADSTONE, B.Sc., (N.S.T.C. '27), M.Sc., (M.I.T. '31), Supt., Venezuela Power Co. Ltd., Maracaibo, Venezuela. (*H*) Parrsboro, N.S. (*S. 1927*) (*Jr. 1929*)

TAYLOR, THOMAS, C.E., (Tor. '07), Engr. of Rlys. and Bridges, Dept. Works, Rm. 313, City Hall, Toronto, Ont. (*H*) 94 Melrose Ave. (*M. 1916*)

TAYLOR, W. R. C., B.Sc., (Man. '29), 135 Provencher Ave., St. Boniface, Man. (*S. 1928*) (*Jr. 1934*)

♂TAYLOR-BAILEY, F. W., Capt., M.C., B.Sc., (McGill '16), Vice-Pres., Dom. Bridge Co., Ltd., P.O. Box 4016, Montreal, Que. (*H*) 3018 Trafalgar Ave. (*S. 1915*) (*A.M. 1919*) (*M. 1930*)

TEAZE, MOSES HAY, B.Sc., (Worcester '17), Partner, H. S. Ferguson, Cons. Engr., 200 5th Ave., New York, N.Y. (*H*) 31 Clarendon Pl., Bloomfield, N.J. (*M. 1926*)

♂TEMPEST, FRANK C., Lieut., R.N.V.R., Refinery Engr., Tropical Oil Co., Barranca, Bermeja, Colombia, S.A. (*H*) 2902–4th St. W., Calgary, Alta., Canada. (*Jr. 1920*) (*A.M. 1926*)

TEMPEST, JOHN SUGDEN, 3902–4th St. W., Calgary, Alta. (*A.M. 1907*) (*M. 1920*) (*Life Member*)

†TEMPLEMAN, GEO. EARL, Chief Engr., Electrical Commn. of the City of Montreal, Rm. 817, Power Bldg., Montreal, Que. (*H*) 147 Strathearn Ave. (*A.M. 1919*) (*M. 1927*)

TENNANT, DAVID COWAN, B.A.Sc., (Tor.), Engr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 156 Easton Ave., Montreal West, Que. (*A.M. 1906*) (*M. 1911*)

♂THEAKSTON, HAROLD RAYMOND, Lieut., B.Sc., (N.S.T.C. '21), Prof. of Engrg. and Engr. i/c Bldgs. and Grounds, Dalhousie University, Halifax, N.S. (*H*) 27 Oakland Rd. (*Jr. 1921*) (*A.M. 1925*)

THEUERKAUF, ALEXANDER PAUL, B.A., Consultant, Dom. Steel and Coal Corpn. Ltd., Sydney, N.S. (*H*) 5 Inglis St. (*M. 1921*)

♂THEXTON, ROBERT DONALD, Major, Box 99, Oxford, N.S. (*Jr. 1919*) (*A.M. 1922*)

THIAN, PROSPER E., A.B., Cons. Engr., N.P. Ry., St. Paul, Minn. (*H*) 93 N. Lexington Ave. (*M. 1906*)

THICKE, J. ERNEST, B.Sc., (Queen's '28), Aluminium Ltd., 1000 Dominion Sq. Bldg., Montreal, Que. (*S. 1926*) (*Jr. 1931*)

THOM, J. EDWIN, B.A.Sc., (Tor. '32), Mech. Engr., Imperial Oil Ltd., Regina, Sask. (*H*) 2220 College Ave. (*S. 1932*)

THOMAS, ARTHUR, Survey Engr., Geographical Sec., Dept. National Defence, Ottawa, Ont. (*H*) 39 Brighton Ave. (*A.M. 1926*)

THOMAS, C. OLDREIVE, 4225 Beaconsfield Ave., Montreal, Que. (*A.M. 1922*)

THOMAS, DAVID RHYS, Mining Engr., 2001 Bloor St W., Toronto, Ont. (*A.M. 1904*) (*M. 1913*)

THOMAS, GEO. H., Siscoe Gold Mines, Siscoe, Que. (*H*) 570 Claremont Ave., Westmount, Que. (*S. 1933*)

THOMAS, GEO. NEVIL, Mgr., Engrg. and Contract Sect., Can Gen. Elec. Co Ltd., Toronto, Ont. (*H*) 231 Wychwood Ave. (*M. 1924*)

THOMAS, JAS. MACLEOD, B.Sc., (N.B. '33), 235 Waterloo Row, Fredericton, N.B. (*S. 1935*)

THOMAS, WM. F., B.Sc., (McGill '30), Address unknown. (*S. 1928*)

THOMPSON, FRANK BLASHFORD, Mgr., Tech. Papers Divn., Ronalds Advertising Agency, Ltd., Keefer Bldg., Montreal, Que. (*H*) Apt. 20, 5192 Decarie Blvd. (*S. 1921*) (*Affil. 1930*)

THOMPSON, FRANK LAWRENCE, B.Sc., (N.S.T.C. '32), Tech. Service Engr., Imperial Oil Ltd., Box 490, Dartmouth, N.S. (*H*) 96 Highfield St., Moncton, N.B. (*S. 1930*) (*Jr. 1935*)

THOMPSON, FRED. GERARD, B.Sc., (N.B. '25), Hillsborough, N.B. (*Jr. 1929*)

♂THOMPSON, GEORGE HARRY, B.Sc., (McGill '13), Chief Engr., Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 822 Riverdale Ave. (*A.M. 1921*)

THOMPSON, HARRY A., B.Sc., (Sask. '27), Fraser Cos. Ltd., Box 686, Edmundston, N.B. (*S. 1927*) (*A.M. 1931*)

♂THOMPSON, HOWARD GRANT, 2nd Lieut., B.A.Sc., (Tor. '22), Mgr., Toronto Office, Can. Vickers, Ltd., 802 Federal Bldg., 85 Richmond St. W., Toronto, Ont. (*H*) 4 Dawlish Ave. (*S. 1920*) (*Jr. 1923*) (*A.M. 1928*)

♂THOMPSON, J. H., Lieut., R.N.C.V.R., B.Sc., Chief Engr., Can. Marconi Co., 211 St. Sacrament St., Montreal, Que. (*H*) 2 Parkside Ave., Montreal West, Que. (*A.M. 1917*)

♂THOMPSON, NORMAN ALBERT, Major, B.Sc., (McGill '12), Hydraulic Engr., Dept. Marine, 532 Hunter Bldg., Ottawa, Ont. Address: c/o Can. Bank of Commerce, Windsor, Que. (*A.M. 1921*)

THOMPSON, PHILIP MANLY, B.A.Sc., (Tor. '08), Deputy Commr. of Bldgs., City of Toronto, Toronto, Ont. (*H*) 27 South Drive. (*A.M. 1921*)

THOMPSON, ROBERT, B.Eng., (McGill '35), 157–17th Ave., Lachine, Que. (*S. 1935*)

♂THOMPSON, TREVOR CREIGHTON, B.Sc., (McGill '20), Engr., The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 4870 Cote des Neiges Rd. (*Jr. 1921*) (*A.M. 1931*)

THOMPSON, VINCENT SWIRE, Designer, Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 92 Duke St. (*A.M. 1931*)

THOMPSON, WILLIAM KIRK, M.A.Sc., (Tor. '22), Metallurgist, U.S. Metals Refining Co., Carteret, N.J. (*H*) 525 Amboy Ave., Woodbridge, N.J. (*A.M. 1920*)

THOMPSON, WM. LENNOX, B.A.Sc., (Tor. '27), Sales Service Engr., Bailey Meter Co. Ltd., Rm. 58, 980 St. Antoine St., Montreal, Que. (*S. 1923*) (*Jr. 1929*) (*A.M. 1935*)

†THOMPSON, WM. T., M.A.Sc., D.L. and D.T.S., S.L.S., M.L.S., Private Practice, Surveyor and Engr., Box 1, Cranberry Portage, Man. (*H*) The Lodge. (*A.M. 1894*) (*M. 1910*) (*Life Member*)

THOMSON, Alexander, Instr'man., Lethbridge Northern Irrigation Dist., Lethbridge, Alta. (*H*) 323-6th Ave. A. S. (*Jr. 1922*) (*A.M. 1925*)

THOMSON, Clarence, B.Sc., (McGill '97), Sec.-Treas., Fred Thomson Co. Ltd., 915 St. Genevieve St., Montreal, Que. (*H*) Apt. C-43, 3490 Cote des Neiges Rd. (*A.M. 1899*) (*M. 1931*)

THOMSON, Elihu, B.Sc., (McGill '31), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 695 Grosvenor Ave., Westmount, Que (*S 1929*)

THOMSON, Frederick, Pres., Fred Thomson Co. Ltd., 915 St. Genevieve St., Montreal, Que. (*H*) 695 Grosvenor Ave., Westmount, Que. (*M. 1889*)

G.†THOMSON, Lesslie R., B.A.Sc., (Tor. '06), Cons. Engr., 1062 New Birks Bldg., Montreal, Que. (*H*) 5626 Woodbury Ave. (*A.M. 1911*) (*M. 1919*)

THOMSON, Reginald Heber, A.B., A.M., Ph.D., Cons. Engr., 925 Seaboard Bldg., Seattle, Wash. (*H*) 1636–34th Ave. (*M. 1913*) (*Life Member*)

†THOMSON, T. Kennard, D.Sc., C.E., (Tor. '86), Cons. Engr., 32 West 40th St., New York, N.Y. (*H*) 30 Madeline Parkway, Yonkers, N.Y. (*M. 1905*)

†THOMSON, W. Chase, Cons. Engr., 437 St. James St. W., Montreal, Que. (*H*) 5551 Queen Mary Rd. (*S. 1887*) (*A.M. 1894*) (*M. 1900*)

THOMSON, Wm. John, B.Sc., (Queen's '27), Chemist, Abrasive Co. of Canada, 858 Burlington St., Hamilton, Ont. (*H*) 75 Gore St. (*Jr. 1931*)

THORN, Richard, Asst. Meter Engr., Imperial Oil Ltd., Imperoyal, N.S. (*H*) 11 MacKay St., Dartmouth, N.S. (*S. 1930*)

THORNE, B. L., Mining Engr., Dept. Nat. Res., C.P.R., Calgary, Alta (*H*) 3027–6th St. S.W. (*M. 1914*)

THORNE, C. B., Vice-Pres., Can. International Paper Co., Hawkesbury, Ont. (*M. 1914*)

THORNE, H. L., B.A.Sc., (B.C. '34), Pioneer Gold Mines of B.C. Ltd., Pioneer Mines P.O., B.C. (*H*) 2455 W. 6th Ave., Vancouver, B.C. (*S. 1928*)

THORNTON, Kenneth B., Gen. Mgr., Montreal Tramways Co., 159 Craig St. W., Montreal, Que. (*H*) 1581 MacGregor St. (*S. 1894*) (*A.M 1899*) (*M. 1920*)

THORNTON, Louis Augustus, B.A., B.Sc., (Queen's '06), Chairman, Sask. Power Comm., Regina, Sask. (*H*) 2244 Smith St. (*M 1915*)

THRUPP, E. C., 2626–13th Ave. W., Vancouver, B.C. (*A.M. 1913*) (*M. 1935*)

♂THURBER, Geo. Henry, Asst. Engr., D.P.W., P.O. Box 1417, Saint John, N.B. (*H*) 244 Princess St. (*Jr. 1920*) (*A.M. 1923*)

THWAITES, Jos. Taylor, B.Sc., (Queen's '25), Engr., Can. Westinghouse Co., Hamilton, Ont. (*H*) 144 Stirton St. (*S. 1924*) (*Jr. 1928*)

TIBBITTS, A. G., B.Sc., (N.S.T.C. '31), Asst. Engr., Acadia Sugar Refining Co. Ltd., P.O. Box 400, Woodside, Dartmouth, N.S. (*H*) Chadwick St (*S. 1930*)

†TIGHE, James L., B.A.Sc., (McGill '92), Cons. Civil and Hydr. Engr., Tighe & Bond, Cons. Engrs., 189 High St., Holyoke, Mass. (*S. 1890*) (*A.M. 1900*) (*M. 1906*)

♂TILLSON, Laurence B., Lieut., M.C., B.A.Sc., (Tor. '15), Address unknown (*S. 1914*) (*A.M. 1920*)

TIMLECK, C. J., B.A.Sc., (B.C. '26), Sales Engr., Can. Ingersoll-Rand Co., Ltd., 175 McDermot Ave. E., Winnipeg, Man. (*H*) Ste. 22, Royal Oak Court. (*S. 1923*) (*Jr. 1931*)

TIMM, Charles Henry, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 343 Lansdowne Ave., Westmount, Que. (*A.M. 1919*)

TIMM, C. Ritchie, B.Sc., (McGill '30), Dom. Engineering Co. Ltd., Montreal, Que. (*H*) 343 Lansdowne Ave., Westmount, Que. (*S. 1928*)

TIMMINS, Wilbur W., B.A.Sc., (Tor. '23), Manufacturers Agent, 344 University Tower, Montreal, Que.; Owner, Zenith Engrg. Co. (*H*) 160-51st Ave., Dixie, Que. (*A.M. 1935*)

TIMMIS, Harold G., B.Sc., (McGill '23), Supt., Groundwood Sulphite and Wood Preparing Depts., Laurentide Div., Consolidated Paper Corpn. Ltd., Grand' Mere, Que. (*S. 1921*) (*A.M. 1929*)

TINKLER, Howard H., B.Eng., (McGill '33), Apt. 1, 4140 St. Urbain St., Montreal, Que. (*S. 1933*)

♂TITUS, Harrison Burrell, Lieut., Transitman, 33 Archibald St., Moncton, N.B. (*A.M. 1921*)

TOBEY, Wilmot Maxwell, M.A., (Tor. '00), D.L.S., D.T.S., Asst. Dir., Geodetic Survey of Canada, Dept. Inter., Ottawa, Ont. (*H*) 231 Fourth Ave. (*M. 1919*)

♂TODD, John Cecil, Lieut., Dist. Engr., Dept. Highways, Sask., Rosetown, Sask. (*A.M. 1921*)

TOLLINGTON, Gordon Chas., B.Sc., (Alta. '32), Designing Engr., Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 351 Charlotte St. (*S. 1932*)

TOMS, Lewis W., 2320 Windsor Rd., Victoria, B.C. (*A.M 1889*) (*Life Member*)

♂TOOKER, Guy L., M.C., Asst. Engr., Roads Dept., City of Vancouver, B.C. (*H*) 1272 Connaught Dr. (*S. 1904*) (*Jr. 1913*) (*A.M. 1930*)

♂TOOKER, Hugh Wakefield, Div. Engr.'s Office, C.N.R., Calgary, Alta. (*H*) 822-A Hillcrest Ave., Mount Royal. (*A.M. 1920*)

♂TOOVEY, Thos. Wm., Cons. Engr., Sulphite Cellulose Expert, Harmanezer Papierfabrik, Harmanec, Nr. Banske Bystrice, Czechoslovakia. (*A.M. 1933*)

♂TOPPING, Victor, M.A., B.Sc., (Tor. '17), (C.E., 24), Cons. Engr., 64 Binscarth Rd., Toronto, Ont. (*A.M. 1923*)

TORRENS, Grover Carleton, B.Sc., (N.B. '06), Div. Engr., C.N.R., Moncton, N.B. (*H*) 202 Queen St. (*A.M. 1921*)

TOUPIN, V., B.A.Sc., (Ecole Polytech., Montreal, '25), St. George Construction Co., Ltd., 4820–4th Ave., Rosemount, Montreal, Que. (*H*) 2186 Souvenir Ave. (*S. 1925*) (*Jr. 1928*) (*A.M. 1932*)

TOUZIN, Thos., B Sc., (Ecole Polytech., Montreal '23), Montreal Water Bd., Montreal, Que. (*H*) 4214 Chambord St. (*Jr. 1925*)

♂TOWNSEND, Chas. Rowlatt, B.Sc., M.Sc., (N.B. '20, '23), Consolidated Paper Corpn. Ltd ; Mgr., Anticosti Island, Port Menier, Anticosti, Que. (*Affil. 1927*) (*A.M. 1934*)

TOWNSEND, David T., B.A.Sc., (Tor.), D.L.S., O.L.S., A.L.S., Chief Surveyor, D.N.R., C.P.R., Calgary, Alta. (*H*) 3810–7th St. W. (*S. 1904*) (*A.M 1913*)

TOWNSEND, Gilbert S. B., Str'l. Engr., Ross & Macdonald, Inc., 1135 Beaver Hall Hill, Montreal, Que. (*H*) 10 Highland Ave. (*A.M. 1909*)

TOY, Edwin L., B.Sc., (N.B. '31), St George Pulp and Paper Co. Ltd., St. George, N B (*S. 1932*)

TOYE, Arthur M., B.A.Sc., (Tor. '25), Sr Dftsman., Dept. Highways, Ont., Parliament Bldgs., Toronto, Ont (*H*) 303 Avenue Rd (*Jr. 1926*) (*A.M 1934*)

TRACY, Edgar Herbert, B.Sc., (N.B '30), 547 Mossam Rd., Toronto, Ont (*Jr 1930*)

TRAILL, J. J., B.A.Sc., (Tor. '06), (C.E., '19), Engr. of Tests, H.E.P.C. of Ont., Toronto, Ont (*H*) 15 Fulton Ave. (*A.M. 1920*) (*M. 1926*)

♂TREGARTHEN, Mark Elmer, B.E., (Sydney '21), Asst. Engr., D.P.W., N.S.W., Box 44-A, G.P.O., Sydney, Australia. (*H*) 165 Bellevue Rd., Bellevue Hill. (*A.M. 1922*)

TREGILLUS, Arthur Louis, Res. Highway Engr., D.P.W., Alta., Old Court House, Calgary, Alta. (*H*) 1328–18th St W. (*A.M. 1933*)

TREMAIN, Kenneth H., B.Sc., (McGill '29), Asst. Sales Mgr., Elias Rogers Co. Ltd., 357 Bay St., Toronto, Ont. (*S. 1928*) (*Jr. 1935*)

TREMBLAY, Altheon, M.A., (Laval), D.L.S., Q.L.S., Private Practice, Tremblay & Drouyn, 147 Cote de la Montagne, Quebec, Que. (*H*) 367 St. Cyrille St. (*S. 1903*) (*A.M. 1906*)

TREMBLAY, Charles, B.A.Sc., (Ecole Polytech., Montreal '32), 5175 Fahre St., Montreal, Que. (*S. 1934*)

♂TREMBLAY, S. N., Major, Engr., Quebec Streams Comm., New Court House, Montreal, Que. (*H*) 22 Prince Arthur St., St. Lambert, Que. (*A.M. 1934*)

♂TREMBLAY, Thos. L., Brig.-Gen., C.M.G., D.S.O., Officer Legion of Honour (French), (R.M.C., Kingston), Gen. Mgr. and Chief Engr., Harbour Comm., Port of Quebec, Quebec, Que. (*H*) 265 Laurier Ave. (*S. 1907*) (*A.M. 1912*)

TRENHOLME, Geo. H., B.Sc., (McGill '24), 601 Clarke Ave., Westmount, Que. (*S. 1924*)

♂TRIMINGHAM, James Harvey, B.Sc., (McGill '08), (M.Sc., '20), Chief Engr., Power Corpn. of Canada, Ltd., 355 St. James St. W., Montreal, Que. (*S. 1907*) (*A.M. 1913*) (*M. 1933*)

TRIPP, Geo. Mason, B.C Electric Rly. Co., Victoria, B.C. (*H*) Langley St. (*A.M. 1919*)

TRIPP, H. H., C.E., (Cornell '08), Div. Engr., C.P.R., Edmonton, Alta. (*H*) 10835–84th Ave. (*A.M. 1919*)

TRISCHUK, Wm., B.Sc., (Sask. '33), Pelly, Sask. (*S. 1933*)

♂TROOP, Stewart, Lieut., (Acadia '07), Rouyn, Que. (*A.M. 1919*)

TROST, Paul Anthony, Engr., Geo. F. Hardy, 305 Broadway, New York, N.Y. (*H*) 160 Vande Linda Ave., Phelps Manor, Teaneck, N.J. (*M. 1921*)

♂TROTTER, Harold L., Lt.-Col., D.S.O., (R.M.C., Kingston '03), Trotter & Cate, Rm. 401, 1111 Beaver Hall Hill, Montreal, Que. (*H*) 900 Sherbrooke St. W. (*S. 1903*) (*A.M. 1907*) (*M. 1922*)

TROWSDALE, Russell S., Dist. Mgr., Can. Gen. Elec. Co., Calgary, Alta. (*H*) 3607–7th St. W. (*A.M. 1919*)

TRUDEAU, Louis-Georges, B.A., (Laval), Dist. Engr., D.P.W., Canada, Rimouski, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1916*)

TRUDEL, Louis, 3450 Berri St., Montreal, Que. (*S. 1934*)

TRUE, Abbott, Lennoxville, Que. (*A.M. 1888*) (*M. 1897*) (*Life Member*)

TRUEMAN, Jas. Cobden, M.Sc., (Man. '24), c/o Design Dept., Dom. Bridge Co. Ltd., Winnipeg, Man. (*Jr. 1924*) (*A.M. 1932*)

TUCK, J. Howard, B.Sc., (Queen's '32), Indust. Engr., Campbell Soup Co., New Toronto, Ont. (*H*) Apt. 3, 55 Beaty Ave. (*S. 1928*)

TUCKER, Ed. Francis, B.S., (Clarkson '32), Vice-Pres. and Mgr., Can. Stebbins Engrg. and Mfg. Co. Ltd., 609 Drummond Bldg., Montreal, Que. (*H*) 5009 Grosvenor Ave. (*A.M. 1934*)

TUCKER, Robert Norman, 123 Chestnut Ave., Hamilton, Ont. (*S. 1934*)

TURLEY, Edward Jas., B.Sc., Mech. Supt., Montreal L., H. and P Cons. 107 Craig St. W., Montreal, Que. (*S. 1906*) (*A.M. 1913*)

♂TURNBULL, Aubrey Arnold, Lieut., B.Sc., (N.S.T.C. '22), Plant Engr., N B. Telephone Co. Ltd., Saint John, N.B (*H*) 3 Mt. Pleasant Court. (*Jr. 1920*) (*A.M. 1926*)

TURNBULL, Donald Orton, (R.M.C., Kingston '29), Foundation Co of Can. Ltd., Falls View Ave., Saint John, N.B. (*Jr. 1932*)

TURNBULL, Jas. Thomson, Dist. Highway Engr., D. of P.W., Box 1268, Saint John, N.B. (*H*) Red Head, N.B. (*A.M 1927*)

TURNER, A. J., B.Sc., (Queen's '32), 119 Maple Ave., Hamilton, Ont. (*S. 1931*)

♂TURNER, Earl Oliver, S.B., (M.I.T. '14), Prof. of C.E., Univ. of N.B., Fredericton, N.B. (*H*) Alexandra St. (*A.M. 1920*)

♂TURNER, Guy Roderick, Lt.-Col., R.C.E., D.C.M., M.C. and Bar, General Staff, Dept. National Defence, Ottawa, Ont. (*H*) 316 Daly Ave. (*S. 1914*) (*Jr. 1914*) (*A.M. 1920*)

TURTLE, Alfred Claude, Elec. and Gen. Engr., Holden Co., Ltd. 736 St James St. W., Montreal, Que. (*H*) 2066 Decarie Blvd. (*Jr. 1921*) (*A.M. 1926*)

TWEEDDALE, Reginald Estey, B.Sc., (N.B. '35), Fraser Cos. Ltd., Edmundston, N.B. (*H*) Arthurette, Victoria Co., N.B. (*S. 1935*)

♂TYLER, William Grant, Lieut., B.Sc., (McGill '15), Cable Engr., Northern Electric Co., Ltd., Montreal, Que. (*H*) 4531 Patricia Ave. (*A.M. 1921*)

♂TYRER, Thos. Geo., Lieut.-Col., S.L.S., Deputy Chief Surveyor, Surveys Br., Land Titles Office, Regina, Sask. (*H*) 2708 Regina Ave. (*A.M. 1931*)

TYRRELL, J. W., C.E., (Tor. '83), J. W. Tyrrell & Co., Ont. and Dom. Land Surveyors, 7 Hughson St., S. Hamilton, Ont. (*H*) 97 Fairholt Rd. (*M. 1919*) (*Life Member*)

♂TYRRELL, Wm. Grant, Col., D.S.O., (R.M.C., Kingston '03), Asst. Director of Transportation, War Office, London, England. (*H*) Elmsleigh Farm, Send, Woking, Surrey. (*S. 1906*) (*A.M. 1912*) (*M. 1921*)

TYSON, Albert Edmund, B.A.Sc., (Tor. '31), Rayner Constrn. Co. Ltd., 29 Commercial St., Leaside, Ont. (*H*) 198 Westminster Ave., Toronto, Ont. (*Jr. 1933*)

ULMANN, Hans, (Fed. Polytech., Zurich '25), Research Engr., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 5995 Terrebonne Ave., Montreal, Que. (*A.M. 1931*)

UMPHREY, Fred. Ellsworth, Dist. Engr., Reclamation Br., D.P.W., Man., Brunkild, Man. (*H*) 182 Niagara St., Winnipeg, Man. (*A.M. 1920*)

G.†UNIACKE, R. F., 235 Wilbrod St., Ottawa, Ont. (*M. 1887*) (*Life Member*)

UPTON, Virgil Stanley, B.Sc., (Sask. '35), Noorduyn Aircraft Ltd., Cartierville, Que. Address: Central Y.M.C.A., Drummond St., Montreal, Que. (*S. 1935*)

URE, Wilfred Gordon, B.A.Sc., (Tor. '13), O.L.S., City and Cons. Engr. and L.S., Wilfred G. Ure, 9 Perry St., Woodstock, Ont. (*H*) 378 Ingersoll Ave. (*A.M. 1922*)

♂URRY, Douglas Percy, Lieut., R.N.V.R., Str'l. Engr., Dom. Bridge Co., Ltd., Vancouver, B.C. (*H*) 3422–1st Ave. W. (*A.M. 1924*)

VALIQUETTE, Adrien, B.Sc., (Montreal '14), Design of Sewers, Tech. Service, City of Montreal, Montreal, Que. (*H*) 808 Rachel St. (*A.M. 1924*)

VALLEE, Ivan E., B.A.Sc., Deputy Minister, Dept. P.W., Parliament Bldgs., Quebec, Que. (*H*) 138 St. Cyrille St. (*S. 1907*) (*Jr. 1913*) (*A.M. 1913*)

VALLIERES, Irenee A., B.Sc., (Ecole Polytech., Montreal '07), Constrn. Engr., Montreal Sewers Comm., City of Montreal, Montreal, Que. (*H*) 35 Duverger Ave. (*S. 1907*) (*A.M. 1927*)

VANCE, Jas. A., Contractor, 288 Light St., Woodstock, Ont. (*S. 1914*) (*Jr. 1919*) (*A.M. 1924*) (*Member of Council, E.I.C.*)

†VANDERVOORT, G. A., Supt. and Elec. Engr., N.B. Electric Power Comm., Provincial Bldg., Saint John, N.B. (*H*) 130 Princess St. (*A.M. 1925*) (*Member of Council, E.I.C.*)

VanEVERY, Wm. Wishart, (Tor. '99), 123 Flatt Ave., Hamilton, Ont. (*A.M. 1905*)

Van KOUGHNET, E. M., (R.M.C., Kingston '22), 157 Notre Dame St., St. Lambert, Que. (*S. 1922*) (*Jr. 1928*)

♂Van NORMAN, Clarence P., Lieut., B.A.Sc., Supt. of Materials, Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 46 St. Germain Ave. (*S. 1909*) (*A.M. 1913*)

♂Van PATTER, Hugh Stanley, M.A., B.Sc., (Queen's '15), D.L.S., Chief Engr., Hydraulic Dept., Dom. Engineering Co., Ltd., Montreal, Que. (*H*) 612 Belmont Ave., Westmount, Que. (*A.M. 1920*)

VAN SCOYOC, Henry Stewart, B.Sc. in C.E., (Penn. '07), Cons. Engr., Canada Cement Co. Ltd., Sta. B, Box 290, Montreal, Que. (*H*) 205 Brock Ave. N., Montreal West, Que. (*A.M. 1915*) (*M. 1921*)

VARCOE, Clifford, Dist. Engr., Provincial Water Rights Br., Dept. of Lands, B.C., P.O. Box 719, Elks Block, Kamloops, B.C. (*H*) 62 Battle St. W. (*A.M. 1917*)

VARLEY, Percy, Can. Industries Ltd., P.O. Box 1260, Montreal, Que. (*H*) 2384 Leclaire St. (*Jr. 1932*) (*A.M. 1935*)

VATCHER, Allan, B.A.Sc., (Tor. '10), Cons. Engr., New Martin Bldg., P.O. Box 86, St. John's, Nfld. (*M. 1924*)

VAUGHAN, Frank P., M.Sc., (N.B. '22), Engr. and Mgr., Vaughan Electric Co. Ltd., 94 Germain St., Saint John, N.B. (*H*) 41 Duke St. (*A.M. 1919*) (*M. 1920*)

†VAUGHAN, Henry Hague, Cons. Engr., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 1539 MacGregor St. (*M. 1906*) (*Past-President*)

VAUGHAN, H. W., B.Sc., (McGill '21), Asst. Supt. and Engr., Light and Pr. Divn., Elec. Dept., City of Montreal, Box 144, Station B, Montreal, Que. (*S. 1920*) (*A.M. 1926*)

♂VAUGHAN, Rupert Henry, Lieut., Asst. Engr., Dept. National Defence, Harrison Mills, B.C. General Delivery, Duncan, V.I., B.C. (*A.M. 1921*)

♂VEITCH, James, Inspecting Engr., Western Canada Fire Underwriters Assoc., Winnipeg, Man. (*H*) Ste. 27, Riverview Mansions. (*A.M. 1920*)

♂VEITCH, W. M., Major, M.C. and Bar, C.E., (R.T.C. Glasgow), City Engr., City of London, Ont. (*A.M. 1922*)

VENNES, Harold J., B.A., (Minn. '16), Special Products Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 53 Curzon St., Montreal West, Que. (*A.M. 1923*)

VERGE, Gerard Arthur, 109 Murray Ave., Quebec, Que. (*S. 1934*)

VERMETTE, J. A., Asst. Engr., D.P.W., Rm. 833, Hunter Bldg., Ottawa, Ont. (*H*) 370 Elgin St. (*A.M. 1914*)

VERMETTE, Narcisse J. A., C.E. and E.E., (Ecole Polytech., Montreal '15), Q.L.S., City Mgr., Shawinigan Falls, Que. (*H*) 182 Broadway Ave. (*S. 1913*) (*A.M. 1920*)

VERNOT, Geo. E., B.Sc., (McGill '26), Res. Engr., Sewer Comm., City of Montreal, Technical Service, City Hall, Montreal, Que. (*H*) 1189 St. George St. (*S. 1923*) (*Jr. 1928*)

VERRIER, Edward John, Asst. Bldg. Supt., Montreal General Hospital, Montreal, Que. (*H*) 865 Dunlop Ave., Outremont, Que. (*Affil 1934*)

♂VESSOT, Chas. U. R., M.Sc., (McGill '22), Wks. Engr., Fry-Cadbury, Ltd., 2025 Masson St., Montreal, Que. (*H*) 845 Kenilworth Rd. (*S. 1916*) (*A.M. 1925*)

VICKERS, Harold, Mech. Engr., Cons. Mining and Smelting Co., P.O. Box 1986, Trail, B.C. (*H*) Bay Ave. (*A.M. 1930*)

VICKERSON, Geo. L., B.Sc., (McGill '25), Mgr., Contr. Dept., G. R. Locker & Co., 1467 Mansfield St., Montreal, Que. (*H*) Apt. 12, 5265 Cote St. Luc Rd. (*S. 1925*) (*Jr. 1928*)

VIENS, Ephrem, B.A., (McMaster '05), Director, Laboratory for Testing Materials, D.P.W., Ottawa, Ont. (*H*) Britannia Heights, Ont. (*A.M. 1919*) (*M. 1925*)

VILLEMURE, J. Philéas, Dftsman. and Instrumentman, City of Grand'Mere, Grand'Mere, Que. (*H*) 174 St. Georges St. (*S. 1931*)

VINCENT, Arthur, Q.L.S., Private Practice, 517 St. Lawrence Blvd., Montreal, Que. (*A.M. 1898*)

VINCENT, Roch Arthur, B.A.Sc., (Ecole Polytech., Montreal '18), Asst. Engr., D.P.W., City of Montreal, Montreal, Que. (*H*) 1704 St. Hubert St. (*A.M. 1927*)

VINCENT, Paul, B.A.Sc., (Ecole Polytech., Montreal '34), 837 Hartland Ave., Outremont, Que. (*S. 1934*)

♂VINET, Eugene, Lieut., B.Sc., (McGill '11), Edison General Electric Appliance Co., Inc., 5600 West Taylor St., Chicago, Ill. (*H*) The Orrington, Evanston, Ill. (*S. 1907*) (*Jr. 1912*) (*A.M. 1917*) (*M. 1925*)

G.VOGAN, Geo. Oliver, B.Sc., (Queen's '17), Engr., i/c Noranda Pr. Dev., 607 University Tower, Montreal, Que. (*H*) 4509 Harvard Ave. (*Jr. 1919*) (*A.M. 1928*)

VOGIN, Maurice A., B.Eng., (McGill '33), 4118 Lafontaine Park, Montreal, Que. (*S. 1930*)

VOKES, Christopher, (R.M.C., Kingston '25), B.Sc., (McGill '27), Capt., c/o O.A., R.C.E., Dept. National Defence, Ottawa, Ont. (*A.M. 1932*)

♂VOLLMER, George Frederick, Capt., M.Sc., (Victoria), Private Practice, 120 York St., St. Catharines, Ont. (*M. 1920*)

von ABO, C. V., B.Sc., M.A., (Cape Town '19), Ph.D., (McGill '22), Chief C.E. Dept., S.A. Rlys. and Harbours, Johannesburg, S. Africa. (*S. 1920*) (*Jr. 1921*) (*A.M. 1930*)

♂VROOM, Harold Heard, Lieut., R.N.V.R., B.Sc., (McGill '10), Supt. of Inspection, Northern Electric Co., Ltd., 1261 Shearer St., Montreal, Que. (*H*) 32 Union Blvd., St. Lambert, Que. (*S. 1908*) (*Jr. 1913*) (*A.M. 1922*)

WADDELL, John A. L., C.E., B.A.Sc., D.Sc., LL.D., D.E., Cons. Engr., Waddell & Hardesty, 142 Maiden Lane, New York, N.Y. (*M. 1903*) (*Life Member*)

♂WADDINGTON, Geo. Wilfred, M.M., B.A.Sc., (B.C. '27), Britannia Mining and Smelting Co., Ltd., Britannia Beach, B.C. (*A.M. 1927*)

WADGE, Norman H., B.Eng., (McGill '35), Rm. 1040, Central Y.M.C.A., Montreal, Que. (*H*) 149 Maryland St., Winnipeg, Man. (*S. 1933*)

WAGNER, Gordon D., Dome Mines, South Porcupine, Ont. (*S. 1932*)

WAGNER, Norman, (Tor. '10), Cons. Str'l. Engr., 378 Queen St. S., Hamilton, Ont. (*A.M. 1921*)

WAIN, John Bernard, Office Engr., Valuation Dept., C.N.R., 1 Toronto St., Toronto, Ont. (*H*) 89 Broadway Ave. (*A.M. 1920*)

WAINWRIGHT, James G. R., B.A.Sc., (McGill '92), Chief Engr., Toronto Harbour Comm., 50 Bay St., Toronto, Ont. (*H*) 63 Heath St. (*S. 1890*) (*A.M. 1899*)

WAITE, Matthew J., B.Sc., (Queen's '31), Aluminum Co. of Canada Ltd., 158 Sterling Rd., Toronto, Ont. (*H*) 65 Colbeck St. (*S. 1931*)

WAKE, Harold Robert, B.Sc., (Nebraska '12), Supt. of Properties, The Aluminum Co. of Canada, Arvida, Que. (*A.M. 1926*)

WAKEFIELD, John Albert, Asst. Dist. Engr., Man. Good Roads Bd., Boissevain, Man. (*A.M. 1918*)

WAKEFIELD, Wm. E., Supervisor of Timber Tests, Forest Products Labs. of Canada, Forest Service, Dept. Inter., Ottawa, Ont. (*H*) 13 Second Ave. (*A.M. 1927*)

WAKEHAM, C. A., B.Sc., (N.B. '28), N.B. Power Co., Dock St., Saint John, N.B. (*H*) 65 Portland St. (*S. 1927*)

WALCOT, John Bevan, D.L.S., Chief of Party, F. A. Gaby, D.Sc., Senneterre, Que. (*H*) 479 Grosvenor Ave., Westmount, Que. (*Jr. 1919*) (*A.M. 1923*)

♂WALCOTT, Wm. D., B.A.Sc., (Tor. '12), Asst. Laboratory Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 13 Parkview Gardens. (*S. 1911*) (*A.M. 1919*)

WALKDEN, William, Bridge Engr., C.N.R., 469 Union Sta., Winnipeg, Man. (*H*) 91 Ferndale Ave., Norwood, Man. (*Jr. 1913*) (*A.M. 1917*)

♂WALKEM, Geo. Alex., Major, B.Sc., (McGill '96), Pres. and Man'g. Dir., Vancouver Machinery Depot, Ltd., 1155-6th Ave. West, Vancouver, B.C. (*H*) 5775 Sperling St. (*A.M. 1906*) (*M. 1920*) (*Past-President*)

WALKEM, Richard, Shop Supt., Vancouver Iron Wks., 1155 W. 6th Ave., Vancouver, B.C. (*H*) 5775 Sperling St. (*S. 1929*)

WALKER, Alex. Harold, B.Sc., (N.B. '34), British Reinforced Concrete Engrg. Co. Ltd., Stafford, England. (*H*) 'Glen Burn,' Ashleigh Rd., Leicester, England. (*S. 1928*)

WALKER, Alfred Paverley, O.L.S., D.L.S., 138 Lascelles Blvd., Toronto 12, Ont. (*A.M. 1888*) (*M. 1898*) (*Life Member*)

WALKER, Andrew, Chief Engr., Fred Thomson & Co. Ltd., Montreal, Que. (*H*) 866 Hartland Ave., Outremont, Que. (*A.M. 1910*) (*M. 1925*)

♂WALKER, John, (Heriot Watt '05), Div. Engr., C.N.R., Allandale, Ont. (*H*) 12 Dunlop St., Barrie, Ont. (*A.M. 1921*)

♂WALKER, J. Alexander, Lieut., B.A.Sc., C.E., B.C.L.S., Civil, Town Planning and Landscape Engr., 626 W. Pender St., Vancouver, B.C. (*S. 1909*) (*Jr. 1911*) (*A.M. 1917*)

WALKER, John Marshall, Engr., Water Supply Sect., Wks. Dept., City of Toronto, Toronto, Ont. (*H*) 7 Hammersmith Ave. (*A.M. 1934*)

WALKER, Melvyn Lothian, B.Sc., (McGill '19), Imperial Oil Ltd., Sarnia, Ont. (*H*) 434 N. Christina St. (*Jr. 1920*) (*A.M. 1930*)

WALKER, Roy Marshall, B.A.Sc., (Tor. '12), Asst. Engr., Engrg. Dept., Montreal L., H. and P. Cons., Montreal, Que. (*H*) 46 First Ave., St. Lambert, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1921*)

WALKER, William, Dist. Engr., C.N.R., McGill St., Montreal, Que. (*H*) 8 Douglas Ave., Westmount, Que. (*A.M. 1910*)

P.†WALL, Arthur Stanford, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 23 Fenwick Ave. (*A.M. 1917*) (*M. 1927*)

WALL, Edward Walter, Sc.B. in C.E., (Brown '10), Vice-Pres. and Gen. Supt., The Atlas Construction Co. Ltd., Montreal, Que. (*H*) 5757 Plantagenet St. (*M. 1923*)

♂WALLACE, George A., Lieut., B.Sc., (McGill '19), (M.Sc., '21), Assoc. Prof., Elec. Engrg., McGill Univ., Montreal, Que. (*H*) 4138 Hingston Ave (*S. 1917*) (*Jr. 1920*) (*A.M. 1925*)

WALLACE, Gordon Leslie, B.A.Sc., (Tor. '12), Cons. Engr., Private Practice, 68 Glenwood Ave., Toronto, Ont. (*A.M. 1923*)

WALLACE, Joseph H., B.Sc., C.E., Cons. Engr., Black-Clawson Co., Hamilton, Ohio. (*H*) 117 N. 30th St. (*A.M. 1901*) (*M. 1902*)

WALLACE, Keith B., B.Sc., (McGill '30), Asst. Supt., Printing Dept., Dom. Oilcloth and Linoleum Co. Ltd., 2200 St. Catherine St. E., Montreal, Que. (*H*) 2270 Notre Dame St. E. (*S. 1929*)

WALLACE, R. H., (R.M.C., Kingston), B.Sc., (McGill '26), Plant Engr., Canada Starch Co., Cardinal, Ont. (*S. 1924*) (*Jr. 1929*)

WALLER, Stephen J. H., Office Engr., C.N.R., Champlain Market Sta., Quebec, Que. (*H*) 14½ Cartier Ave. (*S. 1907*) (*A.M. 1912*)

♂WALLIS, James Harold, Major, Mgr., Dom. Engineering Co. Ltd.; Gen. Mgr., Dom. Hoist and Shovel Co., Ltd., P.O. Box 3150, Montreal, Que. (*H*) 603 St. Joseph St., Lachine, Que. (*A.M. 1921*)

WALLMAN, Clifford Geo., B.Sc., (Man. '34), Prairie Cities Oil Co., Winnipeg, Man. (*H*) 322 Home St. (*S. 1934*)

WALLS, John Abbet, 1611 Lexington Bldg., Baltimore, Md. (*S. 1904*) (*A.M. 1904*)

WALSH, Geoffrey, (R.M.C., Kingston '30), B.Eng., (McGill '33), Capt., R.C.E., Wks. Officer, M.D. No. 6, Engineer Yard, Dept. National Defence, Halifax, N.S. (*S. 1932*)

WALSH, N. Steven, Chief Inspector of Steam Boilers and Pressure Vessels, 88 St. James St. E., Montreal, Que. (*H*) 3434 St. Antoine St. (*A.M. 1923*)

WALSH, Wm. E., Chief Dev. Engr., Illinois Tool Wks., 2501 No. Keeler Ave., Chicago, Ill. Address: P.O. Box 1302, Chicago, Ill. (*Jr. 1921*)

WALSHAW, J. H., Bldg. Inspector, City of Calgary, City Hall, Calgary, Alta. (*H*) 341-3rd Ave. N.E. (*A.M. 1918*)

WALTER, John, B.Sc., (Queen's '33), 2235 Montreal St., Regina, Sask. (*S. 1933*)

WALTON, Clarke Gibbs, B.Sc., (Queen's '15), 205 Peter St. E., Sandwich, Ont. (*A.M. 1928*)

♂WALTON, Frederick Stanley, Roadmaster, C.N.R., P.O. Box 205, Prince Rupert, B.C. (*Jr. 1921*) (*A.M. 1926*)

WANG, Sigmund, (Oslo '09), Mgr. of Laboratories, Can. International Paper Co., Box 350, Hawkesbury, Ont. (*A.M. 1919*) (*M. 1931*)

WARD, Herbert James, Asst. Engr., Shawinigan Water and Power Co., Ltd., P.O. Box 305, Shawinigan Falls, Que. (*A.M. 1924*)

WARD, John Wilmot, B.A.Sc., (Tor. '21), Asst. Engr., Aluminum Co. of Canada, Ltd., Arvida, Que. (*A.M. 1929*)

WARDLE, Edward B., B.Sc., (Dartmouth '99), Chief Engr., Consolidated Paper Co., Grand'Mere, Que. (*M. 1929*)

WARDLE, James Morey, B.Sc., (Queen's '12), Deputy Minister, Dept. Interior, Ottawa, Ont. (*Jr. 1913*) (*A.M. 1916*) (*M. 1925*)

WARDLEWORTH, Theophilus Hatton, B.Sc., (McGill '25), 168 Cote St. Antoine Rd., Westmount, Que. (*S. 1923*) (*Jr. 1931*)

WARKENTIN, C. P., B.Sc., (Man. '26), Dev. and Designing Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 398 London Rd. (*S. 1924*) (*Jr. 1927*)

♂WARNER, John Edwin Archibald, Lieut., M.C., B.Sc., (McGill '12), Chief Engr., St. Regis Paper Co., Deferiet, Jefferson Co., N.Y. (*H*) 413 State St., Carthage, N.Y. (*A.M. 1920*)

WARNOCK, Chas., Pres., Chas. Warnock & Co. Ltd., Engrs., Ste. 1000, McGill Bldg., Montreal, Que. (*H*) 344 Metcalfe Ave., Westmount, Que. (*A.M. 1911*)

WARNOCK, R. N., B.Sc., (McGill '31), Sec.-Treas., Chas. Warnock & Co. Ltd., Ste. 1000, McGill Bldg., Montreal, Que. (*H*) 363 Clarke Ave., Westmount, Que. (*S. 1931*)

WARREN, Hector de la G., B.Sc., C.E., (Queen's), Private Practice, Pointe-au-Pic, Que. (*A.M. 1918*)

WARREN, Pierre, B.A.Sc., (Ecole Polytech., Montreal '32), Asst. Engr., Dept. Public Wks., Rimouski, Que. (*S. 1932*)

†WASS, Silas B., (Tor. '03), Terminal Engr., Toronto; Div. Engr., C.N.R., St. Thomas, Ont. Address: 70 Southwich St., St. Thomas, Ont. (*A.M. 1909*)

♂WATERHOUSE, George Kerby, Lieut., B.Sc., (Queen's '19), Sales Engr., Toronto Iron Wks. Ltd., 620 Cathcart St., Montreal, Que. (*H*) 4459 Old Orchard Ave. (*Jr. 1921*) (*A.M. 1930*)

WATEROUS, Charles A., B.Sc., (McGill), Vice-Pres. and Gen. Mgr., Waterous, Ltd., Brantford, Ont. (*H*) 69 Dufferin Ave. (*S. 1898*) (*A.M. 1903*) (*M. 1909*)

WATERS, William L., Cons. Engr., 137 McGill St., Montreal, Que., and 150 Nassau St., New York, N.Y. (*M. 1918*)

WATIER, A. H., B.Eng., (McGill '32), Shawinigan Water and Power Co., Rapide Blanc, Que. (*S. 1931*)

♂†WATSON, Geo. L., Col., C. de G., D.Eng. C.E., Cons. Engr., 11 West 42nd St., New York, N.Y. (*S. 1906*) (*A.M. 1907*) (*M. 1922*)

WATSON, H. D., B.A.Sc., (B.C. '31), Br. Mgr., Linde Can. Refrigeration Co. Ltd., 124 King St., Winnipeg, Man. (*H*) 61 Furby St. (*S. 1931*)

WATSON, Hugh Monroe, Jr., B.Sc., (McGill '11), Contracting Engr., Dom. Bridge Co. Ltd., P.O. Box 4016, Montreal, Que. (*H*) 660 Belmont Ave., Westmount, Que. (*A.M. 1927*)

♂WATSON, John P., Lieut., B.A.Sc., (Tor. '06), Strl. Engr., D.P.W., Chief Architects' Br., Hunter Bldg., Ottawa, Ont. (*H*) 4186 Melrose Ave., Montreal, Que. (*S. 1907*) (*Jr. 1912*) (*A.M. 1920*)

WATSON, John Tait, City Mgr., Lethbridge, Alta. (*H*) 634-9th St. S. (*A.M. 1925*)

♂WATSON, McClelland Barry, Capt., B.A.Sc., C.E., M.E., (Tor.), Cons. Engr., 121 Welland Ave., Toronto 5, Ont. (*Jr. 1912*) (*A.M. 1919*)

WATSON, Robt. Geo., Watson & Ferguson, 1029 Bank of Hamilton Bldg., Toronto, Ont. (*H*) 202 Albertus Ave. (*A.M. 1921*)

WATTERS, S. Steen, B.Sc., (N.B.), 83 Prince St., W. Saint John, N.B. (*S. 1934*)

♂WAUGH, Bruce Wallace, B.A.Sc., (Tor. '08), D.L.S., Chief of Party, Topographical Survey, Dept. Inter., Ottawa, Ont. (*M. 1922*)

WAY, Ernest Owen, Dir., Weights and Measures, Dept. of Trade and Commerce, West Block, Ottawa, Ont. (*H*) 195 McLeod St. (*A.M. 1919*)

WAY, Wm. Russell, B.Sc., (McGill '18), Asst. Supt. of Operations, Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 4622 Draper Ave. (*S. 1916*) (*Jr. 1919*) (*A.M. 1934*)

WEATHERBE, D'Arcy, c/o Chartered Bank of India, Bishopsgate St., London, E.C., England. (*A.M. 1901*) (*M. 1905*)

♂WEATHERBE, Karl, Major, M.C., B.A., B.Sc., Field Engr., Hamilton Bridge Co., Hamilton, Ont. Address: Box 407, 1441 Drummond St., Montreal, Que. (*A.M. 1904*) (*M. 1906*)

WEATHERBIE, Weston E., B.Sc., (N.S.T.C. '31), Instrumentman, Dept. Highways, N.S. (*H*) 5 Elm St., Truro, N.S. (*S. 1931*) (*Jr. 1932*)

WEBB, Christopher E., B.A.Sc., (Tor. '09), (C.E., '34), Dist. Chief Engr., Dom. Water Power and Hydrometric Bureau, Dept. Interior, 739 Hastings St. W., Vancouver, B.C. (*S. 1911*) (*A.M. 1913*) (*M. 1928*)

WEBB, D. Roland, B.Sc., (N.B. '35), Technician, The Webb Electric Co., 107 Germain St., Saint John, N.B. (*H*) 89 Victoria St. (*S. 1933*)

WEBB, Harry R., M.Sc., (Alta. '22), Asst. Prof., Dept. of C.E., University of Alberta, Edmonton, Alta. (*H*) 8125-112th St. (*S. 1919*) (*Jr. 1927*) (*A.M. 1932*) (*Member of Council, E.I.C.*)

WEBSTER, Chas. Wm., Asst. Res. Engr., Dept. of Highways, Ont., Grimsby, Ont. (*A.M. 1932*)

WEBSTER, R. C. P., B.Sc., (McGill '23), Mgr. and Partner, Maitland Charts, Maitland, Ont. (*S. 1922*) (*A.M. 1931*)

WEEKES, A. S., D.L.S., A.L.S., 61 Maryland St., Winnipeg, Man. (*A.M. 1919*) (*Life Member*)

♂WEEKS, Otis, B.Sc., Div. Engr., Southern Pacific Co., Rm. 201, Union Sta., Ogden, Utah. (*H*) 2529 Eccles Ave. (*A.M. 1907*)

♂WEIBEL, Emil Edwin, Lieut., B.Sc., (McGill '18), Ph.D., Instructor in Mech. Engrg., Univ. of California, Berkeley, Cal. (*H*) 2525 Durant Ave. (*S. 1916*) (*Jr. 1921*) (*A.M. 1924*)

WEIR, Jas., B.Sc., (McGill '13), Asst. Prof. of Geodesy, McGill University, Montreal, Que. (*H*) 416 Wiseman Ave., Outremont, Que. (*A.M. 1922*)

WEIR, Ronald Stanley, Imperial Oil Ltd., Montreal, Que. (*H*) 4876 Cote des Neiges Rd. (*S. 1924*) (*A.M. 1934*)

♂WELCH, Henry Richard, B.Sc., (Queen's '18), Pres., Welch & Johnston, Ltd., 474 Bank St., Ottawa, Ont. (*H*) 477 Island Park Dr. (*S. 1917*) (*Jr. 1923*) (*A.M. 1930*)

WELDON, Richard Laurence, M.Sc., M.E., (McGill '20), Chief Engr., International Paper Co., 220 E. 42nd St., New York, N.Y. (*H*) 30 Hillside Rd., Larchmont, N.Y. (*S. 1915*) (*Jr. 1918*) (*A.M. 1921*) (*M. 1931*)

WELLWOOD, F. Elwin, B.A.Sc., (Tor. '25), Engr., City Architect's Office, City of Toronto, Toronto, Ont. (*H*) 240 Deloraine Ave. (*S. 1921* (*Jr. 1929*)

♂WELLWOOD, Henry, Major, Welland Ship Canal, Welland, Ont. (*H*) 349 N. Main St. (*M. 1921*)

♂WELSFORD, Hubert Gray, Lieut., Gen. Mgr., Dom. Engineering Co. Ltd., P.O. Box 3150, Montreal, Que. (*H*) 27 Barat Rd., Westmount, Que. (*S. 1914*) (*A.M. 1920*)

WELSH, James Gordon, South House, Univ. of Toronto, Toronto, Ont. (*H*) 1078 Valley Way, Niagara Falls, Ont. (*S. 1935*)

WEST, Arthur E., Operating Mgr., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 1634 Gladstone Ave., Windsor, Ont. (*A.M. 1922*) (*M. 1930*)

♂WEST, Chas. Wm., Capt., B.A.Sc., (Tor. '15), Supt. Engr., Welland Ship Canal, Dept. of Rlys. and Canals, St. Catharines, Ont. (*Jr. 1915*) (*A.M. 1920*)

♂WEST, Frank L., Lieut., M.A., B.Sc., (McGill '16), Prof. of Engineering, Mount Allison University, Box 711, Sackville, N.B. (*S. 1915*) (*A.M. 1920*) (*M. 1927*)

WEST, Thomas Macdonald, B.A.Sc., (Tor. '21), Sec.-Treas., J. & J. Taylor Safe Wks. Ltd., 145 Front St. E., Toronto, Ont. (*H*) Stop 10, Kingston Rd. (*S. 1921*) (*Jr. 1924*)

WESTON, Benjamin Thomas, B.C.E., (Maine '00), Engrg. Dept., New England Public Service Co., Madison, Maine. (*M. 1921*)

WESTON, Norman O., B.Sc., (Alta. '35), 11038-87th Ave., Edmonton, Alta. (*S. 1935*)

WESTON, Robert Spurr, B.S., M.A., Cons. Engr., Weston & Sampson, 14 Beacon St., Boston, Mass. (*H*) 81 Griggs Rd., Brookline, Mass. (*M. 1913*)

WESTON, Samuel Raymond, B.Sc., (N.B. '14), Chief Engr., N.B. Electric Power Comm., Saint John, N.B. (*H*) 6 DeMonts St. (*A.M. 1922*) (*M. 1925*)

♂WHEATLEY, Edward Augustus, Capt., M.C. and Bar, Registrar and Sec.-Treas., Assoc. of Prof. Engrs., the Prov. of B.C., 930 Birks Bldg., Vancouver, B.C. (*A.M. 1921*) (*M. 1935*)

WHEATLEY, Eric E., B.Sc., (McGill '30), Sales Engr., Jenkins Bros. Ltd., 617 St. Remi St., Montreal, Que. (*H*) 657 Belmont Ave., Westmount, Que. (*S. 1930*)

WHEATLEY, J. Howard, B.Sc., (McGill '12), Supt., Domestic Gas Appliances, Ltd., 100 Ottawa St., Montreal, Que. (*H*) 4222 Marcil Ave. (*A.M. 1919*)

♂WHELEN, Morland P., B.Sc., (McGill '21), M.Sc., (Tor. '22), Tech. Power Engr., Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont. (*H*) 132 Lawrence Cres. (*S. 1919*) (*Jr. 1923*) (*A.M. 1929*)

WHILLANS, Thos. O., B.Sc., (Queen's '17), Patent Examiner, Patent Office, Ottawa, Ont. (*H*) 22 Sunset Blvd. (*A.M. 1922*)

WHITAKER, A. W., Jr., B.S., (Penn. '13), Chief Engr., Aluminum Co. of Canada, Ltd., Arvida, Que. (*H*) 1 Radin Rd. (*A.M. 1931*)

WHITE, Chas. Edward, Asst. Engr., C.N.R., Rm. 1, Union Sta., Ottawa, Ont. (*H*) 214 Third Ave. (*A.M. 1914*)

♂WHITE, Donald Alex., Major, D.S.O., (R.M.C., Kingston '09), Pres., D. A. White & Co. Ltd., 880 Lagauchetiere St. W., Montreal, Que.; Gen. Mgr., Canada Fire Brick Co. Ltd., 4741 St. Ambroise St., Montreal, Que. (*H*) 1628 Seaforth Ave. (*S. 1909*) (*Jr. 1914*) (*A.M. 1922*)

WHITE, Frank Clinton, B.A.Sc., (Tor. '11), Asst. Engr., Plate and Boiler Dept., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 33 Sterling Ave., Ville La Salle, Que. (*A.M. 1929*)

WHITE, Frank O., B.S. (C.E.), (Maine '05), Chief Engr., Fraser Cos., Ltd., Edmundston, N.B. (*M. 1919*)

WHITE, Harry Manning, (Tor. '10), Chief Engr., Western Divn., Dom. Bridge Co. Ltd., Winnipeg, Man. (*H*) 981 Grosvenor Ave. (*A.M. 1920*)

♂WHITE, Jas. Alex. Gordon, Major, D.S.O., M.C., B.Sc., (McGill '11), Field Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 12 Ridley Blvd. (*S. 1909*) (*A.M. 1920*)

♂WHITE, Jos. Jas., B.Sc., (Sask. '25), Bldg. Inspector, City of Regina, City Hall, Regina, Sask. (*H*) 3320 Pike Ave. (*S. 1924*) (*A.M. 1928*)

WHITE, Robert, Sales Engr., Williams & Wilson, Ltd., 544 Inspector St., Montreal, Que. (*Jr. 1912*) (*A.M. 1914*)

WHITE, Robert John, c/o Mr. Balfour Patterson, Westfield, N.B. (*Affil. 1934*)

WHITE, Ross, B.S., (Iowa), Constrn. Supt., c/o Tennessee Valley Authority, Knoxville, Tenn. (*M. 1928*)

WHITE, Thos. Hy., 1676-16th Ave. W., Vancouver, B.C. (*M. 1887*) (*Life Member*)

WHITE, Thomas W., Dist. Engr., C.N.R., Rm. 217, C.N.R. Depot, Edmonton, Alta. (*H*) 11132-88th Ave. (*A.M. 1909*)

WHITE, Walter Edmund, B.A.Sc., (Tor. '28), Development Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 360 Kensington Ave., Westmount, Que. (*Jr. 1931*)

WHITEHOUSE, Ralph John, B.Eng., (McGill), Consolidated Mining and Smelting Co., Box 1302, Trail, B.C. (*S. 1933*)

WHITELAW, James, (Heriot-Watt), C.N.R., Rm. 603, Can. Express Bldg., McGill St., Montreal, Que. (*H*) 388 Victoria Ave., St. Lambert, Que. (*A.M. 1920*)

♂WHITING, Harold John, A/Capt., Can. International Paper Co. Ltd., Hawkesbury, Ont. (*H*) 3 Smerdon Ave. (*Jr. 1921*) (*A.M. 1926*)

♂WHITMAN, Clyde O., B.Sc., (N.S.T.C. '21), Engr. i/c Project 53, Dept. National Defence, Cavalry Barracks, St. Johns, Que. (*H*) 3534 Marlowe Ave., Montreal, Que. (*Jr. 1919*) (*A.M. 1923*)

♂WHITMAN, Karl Ewart, B.Sc., C.E., (N.S.T.C. '14), Hydraulic Engr., N.S. Power Comm., Halifax, N.S. (*H*) Upper Vaughan, Hants Co., N.S. (*A.M. 1919*)

WHITSON, Duncan David, B.A.Sc., (Tor. '26), City Architects Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 617 Huron St. (*S. 1926*)

♂WHITTAKER, David, Lieut., Dept. Rlys. and Canals, Canal Office, Cornwall, Ont. (*S. 1909*) (*Jr. 1913*) (*A.M. 1919*) (*M. 1931*)

♂WHITTAKER, Herbert James, Sec.-Treas., Municipal District, Manola, Alta. (*Jr. 1921*) (*A.M. 1922*)

WHITTEMORE, Carl Raymond, B.Sc., (McGill '24), Metallurgist, Dom. Bridge Co., Ltd., Box 4016, Montreal, Que. (*H*) 1049 Canora Rd., Town of Mount Royal, Que. (*S. 1921*) (*A.M. 1927*)

♂WHITTIER, Albert Ronald, Lieut., B.Sc., (Queen's '20), Asst. Engr., Rideau Canal, Dept. Rlys. and Canals, Birks Bldg., Ottawa, Ont. (*H*) 84 Grove Ave. (*Jr. 1920*) (*A.M. 1922*)

WHITTIER, Chas. Comfort, B.C.E., (Maine), Pres., Standard Chemical and Mineral Corpn., 332 S. Michigan Ave., Chicago, Ill. (*H*) 6025 University Ave. (*M. 1915*)

†WHITTON, Corbett F., Pres., Construction Products Ltd., 59 Hillyard St., Hamilton, Ont. (*H*) Ancaster, Ont. (*S. 1907*) (*A.M. 1913*)

♂WHYTE, Keith Ogilvie, Elec. Engr., Dom. Bridge Co. Ltd., Box 4016, Montreal, Que. (*H*) 62 Strathearn Ave., Montreal West, Que. (*A.M. 1920*)

WHYTOCK, Jas. W., 318 Heath St. E., Toronto, Ont. (*S. 1932*)

♂†WICKENDEN, Alfred A. (*g*), C.E., (Columbia '10), Q.L.S., Mgr., Lands and Engrg. Dept., Consolidated Paper Corpn. Ltd., 1515 Sun Life Bldg., Montreal, Que. (*H*) 387 Roslyn Ave. (*Jr. 1911*) (*A.M. 1913*)

♂WICKENDEN, John F., B.Sc., (McGill '20), General Contractor, Private Practice, Three Rivers, Que. (*H*) 363 St. Francois Xavier St. (*Jr. 1921*) (*A.M. 1929*)

WICKWIRE, Laurence D., B.Sc., (N.S.T.C. '33), Mersey Paper Co. Ltd., Liverpool, N.S. (*S. 1933*) (*Jr. 1935*)

WICKWIRE, J. L., B.Sc., (McGill '24), Div. Engr., Dept. Highways, N.S., Middleton, N.S. (*Jr. 1927*)

WICKWIRE, W. A. Keith, 56 Edward St., Halifax, N.S. (*S. 1932*)

WIEBE, Victor, B.Sc., Dept. of Marine, Canada, 319 Post Office Bldg., Victoria, B.C. (*S. 1930*)

WIGDOR, Edward I., B.Eng., (McGill '35), Rensselaer Polytechnic Institute, Troy, N.Y. (*H*) 1568 Van Horne Ave., Outremont, Que. (*S. 1934*)

WIGGS, G. Lorne, B.Sc., (McGill '21), Cons. Engr., 509 University Tower, Montreal, Que. (*H*) 4797 Grosvenor Ave. (*S. 1916*) (*A.M. 1927*)

WIGHT, Cecil D., B.Sc., (Queen's '28), O.L.S., Asst. Roadway Engr. and City Surveyor, City of Ottawa, 48 Rideau St., Ottawa, Ont. (*H*) 401 Huron Ave. (*A.M. 1931*)

WIGHTMAN, John, B.Sc., (McGill '22), Supt., Cons. Mining and Smelting Co. of Canada, Ltd., Caribou Gold Mines, Halifax Co., N.S. (*S. 1920*) (*Jr. 1928*) (*A.M. 1934*)

♂WIGHTMAN, John Frederick Carman, Capt., Town Mgr., Kentville, N.S. (*A.M. 1920*)

♂WIGMORE, Roy Douglas Hazen, B.Sc., (Acadia '23), Engr., Omega Gold Mines Ltd., Larder Lake, Ont. Address: P.O. Box 672, Schumacher, Ont. (*A.M. 1931*)

WILBUR, George Percival, Mgr. of Sales, Ontario Div., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 167 Balsam Ave. (*A.M. 1921*)

♂WILCOX, Synney Chas., Major, Div. Engr., C.P.R., Brandon, Man. (*H*) 347–13th St. (*S. 1906*) (*A.M. 1911*)

WILFORD, Frederick R., Pres. and Mgr., F. R. Wilford & Co. Ltd., Lindsay, Ont. (*H*) 24 William St. (*A.M. 1894*) (*M. 1903*)

WILFORD, H. D., B.A.Sc., (Tor. '25), County Engr. and Rd. Supt., County of Victoria, Court House, Lindsay, Ont. (*H*) 18 Regent St. (*Jr. 1924*)

WILFORD, John R., Supt. and Sec., F. R. Wilford & Co., Ltd., P.O. Box 119, Lindsay, Ont. (*H*) 4 William St. S. (*S. 1920*) (*A.M. 1934*)

♂WILGAR, William P., Lt.-Col., D.S.O., B.Sc., (Queen's '03), Prof. of C.E., Queen's University, Kingston, Ont. (*S. 1902*) (*A.M. 1905*) (*M. 1909*)

WILKIE, Edward T., 56 Marmaduke St., Toronto, Ont. (*A.M. 1904*) (*M. 1916*) (*Life Member*)

WILKINS, Ronaln E., (R.M.C., Kingston '35), Lieut., R.C.E., 132 Earle St., Kingston, Ont. (*S. 1935*)

♂WILKINSON, J. B., Lieut., B.Sc., Colas Roads, Ltd., 21 Dundas Sq., Toronto, Ont. Address: Hotel Cornwallis, Cornwall, Ont. (*A.M. 1918*)

WILLIAMS, Arthur S., B.Sc., (Man. '21), Chief Operator, Northbwestern Power Co., Ltd., Seven Sisters Falls, Man. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

WILLIAMS, C. Scott, B.Sc., (N.S.T.C. '32), P.O. Box 209, Antigonish, N.S. (*S. 1932*)

WILLIAMS, Davin G., B.Sc., (Alta. '33), (M.Sc., '35), Pilot Officer, R.C.A.F., Officers' Mess, Camp Borden, Ont. (*H*) 10152–113tb St., Edmonton, Alta. (*S. 1933*)

WILLIAMS, Edw. C., Mgr., Heating and Cooling Divn., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto. Ont. (*H*) 187 Keewatin Ave. (*Jr. 1930*) (*A.M. 1934*)

WILLIAMS, Frank, Mech. Engr., C.N.R., Rm. 201, Can. Nat. Express Bldg., Montreal, Que. (*H*) 592 Davaar Ave. (*A.M. 1921*)

†WILLIAMS, Guy Morris, B.Sc., C.E., (Nebraska '11), Prof. of Civil Engrg., University of Saskatchewan, Saskatoon, Sask. (*A.M. 1920*)

WILLIAMS, Leslie Chevers, B.Sc., (Queen's '32), Apt. 402, 89 Breadalbane St., Toronto, Ont. (*H*) 23 Ossington Ave., Ottawa, Ont. (*S. 1934*)

WILLIAMS, Richarn Louis, B.Sc., (McGill '31), 159–24th Ave., Lachine, Que. (*S. 1930*) (*Jr. 1933*)

WILLIAMS, Stanley Chevers, B.Sc., (Queen's '35), 23 Ossington Ave., Ottawa, Ont. (*S. 1935*)

WILLIAMSON, David Allen, B.A.Sc., (Tor. '99), Strl. Engr., Chief Architect's Br., D.P.W., Canada, Ottawa, Ont. (*H*) 728 Echo Dr., Ottawa, Ont. (*A.M. 1912*)

WILLIAMSON, F. Stuart, Cons. Engr., 474 St. Alexis St., Montreal, Que. (*H*) 2150 Tupper St. (*M. 1893*) (*Life Member*)

WILLIS, Ralph R., B.Sc., (N.B. '31), West Bathurst, N.B. (*S. 1931*)

WILLIS, R. W., B.Sc., (Queen's '27), Engr. and Designer, Bridge and Rly. Dept., Rm. 313, City Hall, Toronto, Ont. (*H*) 373 Castlefield Ave. (*Jr. 1929*) (*A.M. 1935*)

WILLOWS, Fren, B.Sc., (Man. '29), 442 Boyd Ave., Winnipeg, Man. (*S. 1929*)

♂WILMOT, L. Allan, Major, M.C., (R.M.C., Kingston '11), C.E., (Wis. '14), 67 Yonge St., Toronto, Ont. (*H*) 217 Glengrove Ave. W. (*A.M. 1929*)

♂WILSON, Alexanner, Lieut., B.Sc., (McGill '10), Cons. Engr., Wilson & Kearns, 317 New Birks Bldg., Montreal, Que. (*H*) 3427 Simpson St. (*A.M. 1920*)

WILSON, A. McD., B.Sc., (Queen's '28), Asst. Engr., Algoma Central and Hudson Bay Rly., Sault Ste. Marie, Ont. (*H*) Apt. S, Tara Hall. (*Jr. 1929*)

WILSON, Clifforn St. J., B.Sc., (McGill '11), Pickings & Wilson, 521 Roy Bldg., Halifax, N.S. (*H*) 9 Wacgwoltic Ave. (*Jr. 1913*) (*A.M. 1919*)

♂WILSON, Elnon Parker, Capt., B.Sc., (McGill '20), Brompton Pulp and Paper Co. Ltd., East Angus, Que. (*Jr. 1920*) (*A.M. 1927*)

WILSON, Ellwood, B.A., B.Sc., (South Tenn., '93), Box 23, Knowlton, Que. (*M. 1922*)

WILSON, H. Alton, Sales Engr., Can. Fairbanks-Morse Co. Ltd., Montreal, Que. (*H*) 550 Claremont Ave., Westmount, Que. (*A.M. 1922*)

♂WILSON, Jas. Clarence, B.A.Sc., (Tor. '16), Supt., Corpn. of Ottawa Filtration Plant, Ottawa, Ont. (*H*) 317 Lyon St. (*S. 1914*) (*A.M. 1925*)

WILSON, Jas. Harvey, B.Sc., (Man. '25), Elec. Engr., Dr. F. A. Gaby, 608 University Tower, Montreal, Que. (*H*) 4543 Wilson Ave. (*S. 1924*) (*A.M. 1929*)

♂WILSON, John A., Lieut., Res. Engr., Middlesex County Council. (*H*) 66 Rugby Ave., Wembley, Middlesex, England. (*A.M. 1913*)

♂WILSON, John Armitstead, Controller of Civil Aviation, Dept. of National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 178 Rideau Terrace. (*A.M. 1910*)

♂WILSON, John S., Lieut., M.C., B.A.Sc., (Tor. '20), Gen. Mgr., Dryden Paper Co., Ltd., Dryden, Ont. (*Jr. 1919*) (*A.M. 1923*) (*M. 1930*)

♂†WILSON, LeRoy Z., Major, M.C., B.A.Sc., (Tor. '11), Engr. i/c Operations, Evans, Deakin-Hornibrook Construction Pty. Ltd., Ryan House, Charlotte St., Brisbane, Australia. (*S. 1910*) (*Jr. 1913*) (*A.M. 1915*) (*M. 1923*)

♂WILSON, Norman, Lieut., B.Sc., (C.E.), (N.B. '13), Asst. Hydrographic Survey, Dept. Marine, 254 Hunter Bldg., Ottawa, Ont. (*H*) 68 Brighton Ave. (*S. 1912*) (*Jr. 1916*) (*A.M. 1919*)

WILSON, Norman D., B.A.Sc., (Tor. '04), C.E., D.L.S., O.L.S., Wilson & Bunnell, Cons. Engrs., 388 Yonge St., Toronto, Ont. (*H*) 128 Glen Rd. (*S. 1905*) (*A.M. 1910*) (*M. 1925*)

WILSON, Robert S. L., Dean of the Faculty of Applied Science and Prof. C.E. and Municipal Engrg., University of Alberta, Edmonton, Alta. (*H*) 11119–86th Ave. (*S. 1907*) (*A.M. 1913*) (*M. 1926*)

♂WILSON, Selwyn Hamilton, Lieut., M.C., B.Sc., (McGill '22), 118 Lisgar St., Ottawa, Ont. (*S. 1920*) (*A.M. 1925*)

WILSON, Thos. W., B.A.Sc., (Tor. '33), 60 Brookdale Ave., Toronto, Ont. (*S. 1932*)

♂WILSON, Wm. Fairbairn, Cons. Engr., R.R. 1, East Sooke, V.I., B.C. (*A.M. 1934*)

WILSON, William Smith, Chief Engr., Dom. Steel and Coal Corp. Ltd., Sydney, N.S. (*H*) 847 George St. (*A.M. 1921*)

♂WILSON, Wm. Stewart, Major, B.A.Sc., (Tor. '21), Secy., Faculty of Applied Science, University of Toronto, Toronto 10, Ont. (*H*) 20 Humewood Dr. (*S. 1921*) (*A.M. 1926*) (*M. 1935*) (*Sec.-Treas., Toronto Br., E.I.C.*)

♂WILSON, Wm. Thomas, Major, D.S.O., M.C. and Bar, "Tower of Lettrick," Dunscore, Dumfriesshire, Scotland. (*A.M. 1906*)

♂WINDELER, Henry Stanton, Major, M.C., B.Sc., (McGill '14), Chief Engr., Anglo-Newfoundland Development Co. Ltd., Grand Falls, Nfld. (*S. 1912*) (*A.M. 1921*)

WINDER, John, Elec. Engr., Molsons Brewery Ltd., 1670 Notre Dame St. E., Montreal, Que. (*H*) 5400 Waverley St. (*Affil. 1934*)

WINDSOR, Maurice, Can. Mgr., Armstrong Siddeley Motors Ltd., Slater St., Ottawa, Ont. (*A.M. 1935*)

WINFIELD, James Henry, Managing Dir., Maritime Telegraph and Telephone Co. Ltd., P.O. Box 110, Halifax, N.S. (*M. 1918*)

WINFIELD, W. A., Gen. Mgr. and Gen. Supt. of Plant, Maritime Telegraph and Telephone Co. Ltd., P.O. Drawer 110, Halifax, N.S. (*H*) 100 Oakland Rd. (*M. 1920*)

WING, Daniel Oscar, (Tor. '08), D.L.S., B.C.L.S., Asst. Supt., Gas Dept., Montreal L., H. and P. Cons., Montreal, Que. (*H*) 4078 Hampton Ave. (*A.M. 1917*)

WINN, James, B.Eng., (McGill '35), Anglo-Can. Pulp and Paper Co. Ltd., Quebec, Que. (*H*) 27 Charlevoix St. (*S. 1935*)

♂WINSLOW, Kenelm Molson, Lieut., B.Sc., (McGill '21), Sales Engr., Dom. Engineering Co. Ltd., P.O. Box 3150, Montreal, Que. (*H*) 22 Riverside Dr., Lachine, Que. (*Jr. 1922*) (*A.M. 1934*)

WINSLOW-SPRAGGE, E., B.Sc., (McGill '08), Gen. Mgr., Can. Ingersoll-Rand Co. Ltd., 620 Cathcart St., Montreal, Que. (*H*) 55 Aberdeen Ave., Westmount, Que. (*A.M. 1920*)

WINSOR, Rolann B., B.Sc., (McGill '27), Wks. Mgr., Can. Industries, Ltd., Shawinigan Falls, Que. (*Jr. 1927*)

WINTER, F. E., B.Sc., (McGill '26), 4684 Westmount Ave., Westmount, Que. (*S. 1924*)

WIREN, Robt. C., B.A.Sc., (Tor. '26), Lecturer, University of Toronto, Rm. 14, Mech. Bldg., Toronto, Ont. (*H*) East House Men's Residence. (*A.M. 1929*)

WISDOM, Chas. S. C., B.C., (McGill '35); (R.M.C., Kingston), 47 Hemlock Ave., Shawinigan Falls, Que. (*S. 1935*)

WISE, Alfren J., B.Sc., M.Sc., (McGill '27), 6648–3rd Ave., Rosemount, Montreal, Que. (*S. 1925*)

WISHART, W. D., B.Sc., (Man. '31), Lieut., R.C.C.S., Camp Borden, Ont. (*S. 1932*) (*Jr. 1934*)

WITHROW, J. Frederick D., (Tor. '00), Reg'd. Patent Attorney, Hazard & Miller, 706 Central Bldg., Los Angeles, Calif. (*H*) 5251 La Roda Ave., Eagle Rock P.O. (*A.M. 1921*)

WOLFF, Aage Oscar, Div. Engr., C.P.R., London, Ont. (*H*) 504 Baker St. (*A.M. 1920*) (*M. 1926*)

WOLFF, Martin, 442 Argyle Ave., Westmount, Que. (*S. 1906*) (*A.M. 1911*)

WONG, Henry G., B.Eng., (McGill '35), 1090 Chenneville St., Montreal, Que. (*S. 1934*)

WOOD, Albert L., B.Sc., (N.S.T.C., '33), 14 Black St., Halifax, N.S. (*S. 1930*)

WOOD, Charles O., 154 Cameron St., Ottawa, Ont. (*A.M. 1904*)

WOOD, D. W., B.Sc., (Sask. '31), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. W. (*S. 1931*)

♂*G.*†WOOD, Frederick Morris, M.A., B.Sc., (Queen's '14), Asst. Prof., McGill University, Engrg. Bldg., Montreal, Que. (*H*) 6–44th Ave., Lachine, Que. (*A.M. 1920*)

♂WOOD, George Howard, Lieut., B.A.Sc., (Tor. '17), C.E., '30, Asst. Engr., Dom. Water Power and Hydrometric Bureau, Dept. Inter., Niagara Falls, Ont. (*H*) 1929 Delaware St. (*Jr. 1921*) (*A.M 1922*)

WOOD, Jas. Robt., (A.R.T.C. '11), Asst. City Engr., City Hall, Calgary, Alta. (*H*) 818–18th Ave. W. (*A.M. 1919*) (*M. 1935*)

WOOD, Robert, B.Sc., (McGill '24), Executive Asst., Quebec Power Co., Power Bldg., Quebec, Que. (*H*) 58 Brown Ave. (*S. 1921*) (*A.M. 1934*)

WOODARD, Silas H., B.Sc., (Mich. '99), Cons. Engr., 10 East 40th St., New York, N.Y. (*M. 1910*)

WOODHALL, T. L., B.Sc., (Man. '30), (M.Sc., '34), 441 College Ave., Winnipeg, Man. (*S. 1930*)

WOODMAN, John, Engr. and Arch't., 504 River Ave., Winnipeg, Man. (*A.M. 1896*) (*M. 1897*) (*Life Member*)

WOODS, Francis Cenric, B.Sc., (N.B. '27), City of Westmount, City Hall, Westmount, Que. (*H*) 759 Moffat Ave., Verdun, Que. (*S. 1927*)

WOODS, Jos. Edward, 252 Wilbrod St., Ottawa, Ont. (*A.M. 1887*) (*Life Member*)

WOODS, Wm. Daniel, B.Sc., (N.S.T.C. '34), Armdale P.O., Halifax, N.S. (*S. 1930*)

WOODSIDE, Jas., B.A.I., (Dublin '14), Engr., Can. Hydro-Electric Corp. Ltd., 140 Wellington St., Ottawa, Ont. (*H*) 43 Fulton Ave. (*A.M. 1926*)

WOODYATT, James Blain, B.Sc., (McGill), Pres. and Gen. Mgr., Southern Canada Power Co. Ltd., 355 St. James St., Montreal, Que. (*H*) 3197 Westmount Blvd., Westmount, Que. (*S. 1907*) (*A.M. 1916*) (*M. 1931*)

WOOLSEY, John T., Lieut., Work Point Barracks, Esquimalt, B.C. (*H*) 499 Gilmour St., Ottawa, Ont. (*S. 1932*)

♂WOOLWARD, Charles Desmond, B.Sc., (McGill '23), Sales Engr., Electric Tamper and Equipment Co. of Can. Ltd., Rm. 801, Keefer Bldg., Montreal, Que. (*S. 1921*) (*Jr. 1926*) (*A.M. 1930*)

WOOTTON, Allan S., Chief Engr., Bd. of Parks Commrs., Stanley Park, City of Vancouver, B.C. (*H*) 975 Lagoon Dr., Vancouver, B.C. (*M. 1923*) (*Member of Council, E.I.C.*)

WORCESTER, Wolsey Garnet, (Ohio '99), Prof., Ceramic Engrg., University of Saskatchewan, Saskatoon, Sask. (*M. 1923*)

♂WORKMAN, Samuel Fraser, Major, M.C., c/o Quadra Club, Vancouver, B.C. (*A.M. 1920*)

WORKMAN, Wm. Ross, B.A.Sc., (B.C. '30), Coal Creek, B.C. (*S. 1927*)

WORTHINGTON, Wm. Robert, B.A.Sc., (Tor. '05), Pres., W. R. Wortbington Constrn. Co. Ltd., Toronto, Ont. (*H*) 57 Lascelles Blvd. (*A.M. 1916*)

WOZNOW, John, B.Sc., (Alta. '35), University of Alberta, Edmonton, Alta. (*H*) Medicine Hat, Alta. (*S. 1935*)

WRANGELL, K. F., Mech. Engr., E. B. Eddy Co. Ltd., Hull, Que. (*Jr. 1931*) (*A.M. 1935*)

WRIGHT, ARCH'D. E., West Kootenay Power and Light Co. Ltd., Box 76, Rossland, B.C. (*M. 1920*)

♂WRIGHT, ATHOL C., Capt., Supt., Jasper National Park, Jasper, Alta. (*S. 1908*) (*A.M. 1919*) (*M. 1922*)

WRIGHT, C. A., B.Sc., (N.S.T.C., '35), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 333 Reid St., Peterborough, Ont. (*S. 1930*)

WRIGHT, C. H., B.A.Sc., (McGill '96), Dist. Mgr., Can. Gen. Elec. Co. Ltd., Halifax, N.S. (*H*) 110 Oxford St. (*M. 1918*)

WRIGHT, GEORGE R., B.A., (Mt. All. '03), B.Sc., (McGill '07), Dist. Mgr., Can. Gen. Elec. Co. Ltd., 1065 Pender St. W., Vancouver, B.C. (*H*) 1541–29th Ave. W. (*A.M. 1920*)

WRIGHT, H. SINCLAIR, B.Sc., (N.S.T.C. '27), Gen. Supt. and Chief Engr., Demerara Elec. Co., Ltd., Georgetown, British Guiana. (*H*) St. Peter's, N.S., Canada. (*S. 1922*) (*Jr. 1931*)

WRIGHT, JAMES A., James A. Wright & Associates, P.O. Box 25, Ontario, Cal. (*H*) 1229 S. Palmetto Ave. (*M. 1922*)

WRIGHT, NOEL N., B.Sc., (Illinois '28), Sales Engr., Ferranti Electric Ltd., 508 Power Bldg., Montreal, Que. (*H*) 5876 Somerled Ave. (*Jr. 1928*)

WURTELE, JOHN STONE HUNTER, Vice-Pres. and Plant Mgr., Southern Canada Power Co.; Plant Mgr., Power Corpn. of Canada, 355 St. James St., Montreal, Que. (*H*) 756 Upper Lansdowne Ave., Westmount, Que. (*M. 1917*)

WYLLIE, F. J., B.Sc., 10913–73rd Ave., Edmonton, Alta. (*S. 1932*)

♂WYMAN, HUGH KENNEDY, Lieut., M.C., M.M., B.A.Sc., (Tor. '15), 15 Champlain St., Shawinigan Falls, Que. (*A.M. 1925*)

♂WYMAN, JOHN KIRBY, Major, B.Sc., Supt., Govt. Grain Elevators, Dept. Rlys. and Canals, Prescott, Ont. (*H*) 350 James St. (*S. 1907*) (*A.M. 1912*)

WYNN, GUY MONTAGUE, Vice-Pres., T. Pringle & Son, Ltd., 410 St. Nicholas St., Montreal, Que. (*H*) 2985 Cedar Ave. (*A.M. 1915*) (*M. 1926*)

♂YACK, WILFRID LAURIER, B.A.Sc., (Tor. '22), Babcock-Wilcox & Goldie-McCulloch Ltd., Montreal, Que. (*H*) 3454 Walkley Ave. (*A.M. 1929*)

YARROW, N. A., Gen. Mgr., Yarrows, Ltd., P.O. Box 820, Victoria, B.C. (*A.M. 1918*)

YAPP, RAYMOND A., B.Sc., (London '21), Sales Mgr., Bepco Canada Ltd., 1050 Mountain St., Montreal, Que. (*H*) 5027 Glen Cairn Ave. (*A.M. 1934*)

YATES, JOHN MUNRO, 147 Lambton Ave., Toronto 9, Ont. (*S. 1933*)

YEOMANS, R. H., B.Sc., (McGill '30), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 55 Wolseley Ave., Montreal West, Que. (*S. 1928*) (*Jr. 1933*)

YORGAN, WM. JAS., Supt., Mains Services Gas, Montreal L., H. and P. Cons., 107 Craig St. W., Montreal, Que. (*H*) 3791 Vendome Ave. (*A.M. 1932*)

YORK, FRED. GILBERT, B.Eng., (McGill '35), 1441 Drummond St., Montreal, Que. (*S. 1935*)

YORSTON, WM. G., (R.M.C., Kingston), Queen St., Truro, N.S. (*M. 1914*) (*Life Member*)

YOST, WINFIELD HANCOCK, Pres., Yost Rly. Supplies Ltd., Montreal, Que (*H*) 4050 Marlowe Ave. (*A.M. 1924*)

♂†YOUNG, ALEXANDER A., Major, B.Sc., (McGill '10), 9 Willow Ave., Westmount, Que. (*S. 1909*) (*A.M. 1913*)

†YOUNG, CLARENCE R., Major, B.A.Sc., C.E., (Tor. '05), Prof. of Civil Engineering, Univ. of Toronto, Toronto, Ont; Cons. Engr. (*H*) 119 Glenayr Rd. (*S. 1903*) (*A.M. 1908*) (*M. 1913*)

YOUNG, GILBERT M., B.Sc., (McGill '34), 6347–24th Ave., Rosemount, Montreal, Que. (*S. 1934*)

YOUNG, JOHN, (Tor. '07), 201 Scotia St., Winnipeg, Man. (*A.M. 1920*)

YOUNG, JOHN DOUGLAS, B.Sc., (Queen's '27), Bailey Meter Co. Ltd., 980 St. Antoine St., Montreal, Que. (*Jr. 1931*)

†YOUNG, RODERICK BEARCE, B.A.Sc., (Tor. '13), (C.E., '19), Test. Engr., i/c Chem. and Engrg. Material Labs., H.E.P.C. of Ontario, 620 University Ave., Toronto, Ont. (*H*) 30 Brummell Ave. (*S. 1911*) (*Jr. 1916*) (*A.M. 1918*) (*M. 1923*)

YOUNG, STEWART, B.A.Sc., (Tor. '12), Director of Town Planning, Sask., Dept. Municipal Affairs, Regina, Sask. (*H*) 2822 Rae St. (*A.M. 1917*) (*M. 1935*) *Sec.-Treas., Sask. Br., E.I.C.; Member of Council, E.I.C.*)

♂YOUNG, W. BRAND, Lieut., Trail's End Lodge, Quesnel Lake, Likely P.O., B.C. (*A.M. 1919*)

YOUNG, WM. R., B.Sc., (Man. '28), c/o Lamaque Gold Mines, Ltd., Val d'Or, Via Amos, Que. (*S. 1924*)

YOUNGER, H. R., B.Sc., (McGill '10), Div. Engr., C.P.R., Box 534, Nelson, B.C. (*A.M. 1913*)

♂YUILL, A. C. R., Lieut., R.N.V.R., O.B.E., Cons. Engr., 626 Pender St. W., Vancouver, B.C. (*H*) 5162 Marguerite St. (*A.M. 1919*) (*M. 1927*)

♂ZEALAND, E. L., Lieut., B.A.Sc., (Tor. '24), Dept. Northern Development, White River, Ont. (*H*) P.O. Box 172, Burlington, Ont. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

ZION, ALFRED BERNARD, B.Eng., (McGill '35), Prod. Engr., Dom. Lock Co. Ltd., 3770 Henri Julien Ave., Montreal, Que. (*H*) 5280 Byron St. (*S. 1935*)

ZUERCHER, MAX, 4103 Marlowe Ave., Montreal, Que. (*M. 1889*) (*Life Member*)

ZWICKER, B. H. C., B.Sc., (N.S.T.C. '30), 4 Tower Terrace, Halifax, N.S. (*S. 1928*)

GEOGRAPHICAL LIST OF MEMBERS

CORRECTED TO OCTOBER 15th, 1935

(Names of Members temporarily on the Non-Active List have not been included)

ZONE A

(*The four Western Provinces.*)

Victoria Branch District

(*Vancouver Island and the Gulf Islands Tributary to Vancouver Island.*)

Albert Head (Br. Res.), MEMBER, J. H. Gray.

Cadboro Bay (Br. Res.), ASSOCIATE MEMBER, A. W. Ferguson.

Duncan (Br. Non-Res.), ASSOCIATE MEMBER, R. H. Vaughan.

East Sooke (Br. Res.), ASSOCIATE MEMBER, W. F. Wilson.

Headquarters (Br. Non-Res.), ASSOCIATE MEMBER, H. E. Stevens.

Nanaimo (Br. Non-Res.), ASSOCIATE MEMBER, A. G. Graham.

Saanich (Br. Res.), MEMBER, A. L. Ford.

Victoria (Br. Res.), MEMBERS, R. A. Bainbridge, A. L. Carruthers, E. Davis, J. S. Dennis, G. M. Duncan, C. W. Gamble, F. C. Green, J. E. Griffith, A. E. Hodgins, H. T. Hughes, G. M. Irwin, J. C. MacDonald, K. Moodie, G. P. Napier, F. J. O'Reilly, G. L. Stephens, H. L. Swan; ASSOCIATE MEMBERS, J. N. Anderson, I. C. Barltrop, J. H. Blake, W. N. Bostock, H. F. Bourne, E. C. G. Chambers, R. F. Davy, W. S. Drewry, M. J. Evans, R. C. Farrow, S. H. Frame, H. N. Gahan, A. J. Gray, E. I. W. Jardine, F. W. Knewstubb, D. MacBride, J. H. McIntosh, G. Phillips, L. W. Toms, G. M. Tripp, N. A. Yarrow; JUNIORS, W. M. Davidson, K. Reid, C. D. Schultz; STUDENTS, J. O. Johnson, W. S. B. Latta, M. C. Nesbitt, V. Wiebe.

Vancouver Branch District

(*The balance of British Columbia, except that allocated to Lethbridge Branch.*)

Atlin (Br. Non-Res.), ASSOCIATE MEMBER, A. M. Ross.

Bridge River (Br. Non-Res.), ASSOCIATE MEMBER, S. H. Davis.

Britannia Beach (Br. Non-Res.), ASSOCIATE MEMBER, G. W. Waddington.

Choate (Br. Non-Res.), ASSOCIATE MEMBER, H. L. Cairns; STUDENT, E. J. Merrett.

Deer Park (Br. Non-Res.), ASSOCIATE MEMBER, C. S. Moss.

Fort St. James (Br. Non-Res.), ASSOCIATE MEMBER, W. M. Ogilvie.

Kamloops (Br. Non-Res.), ASSOCIATE MEMBER, C. Varcoe.

Kelowna (Br. Non-Res.), MEMBERS, F. W. Groves, G. Stirling; ASSOCIATE MEMBER, D. K. Penfold.

Ladner (Br. Res.), ASSOCIATE MEMBER, C. E. Cooper.

Likely (Br. Non-Res.), ASSOCIATE MEMBER, W. B. Young.

Nelson (Br. Non-Res.), MEMBER, A. L. McCulloch; ASSOCIATE MEMBERS, J. P. Coates, H. R. Younger.

New Westminster (Br. Res.), MEMBERS, L. B. Elliot, J. P. Forde; ASSOCIATE MEMBERS, G. D. Dixon, W. E. Keyt, J. B. Lambert, G. MacLeod, F. O. Mills, C. Raley, E. Smith, G. N. Stowe; STUDENT, F. E. Ladner.

Ocean Falls (Br. Non-Res.), ASSOCIATE MEMBERS, H. M. Lewis, A. S. Mansbridge.

Oliver (Br. Non-Res.), ASSOCIATE MEMBER, D. G. McCrae.

Penticton (Br. Non-Res.), MEMBERS, F. H. Latimer, A. McCulloch, T. E. Naish; ASSOCIATE MEMBER, R. A. Barton.

Pouce Coupe (Br. Non-Res.), ASSOCIATE MEMBER, H. L. Hayne.

Powell River (Br. Non-Res.), MEMBER, W. Jamieson; ASSOCIATE MEMBERS, N. Beaton, R. Bell-Irving.

Prince Rupert (Br. Non-Res.), ASSOCIATE MEMBERS, W. L. Stamford, F. S. Walton.

Premier (Br. Non-Res.), JUNIOR, A. I. E. Gordon.

Rossland (Br. Non-Res.), MEMBER, A. E. Wright.

Salmo (Br. Non-Res.), ASSOCIATE MEMBER, I. M. Marshall.

Salmon Arm (Br. Non-Res.), ASSOCIATE MEMBER, V. J. Melsted.

Smithers (Br. Non-Res.), ASSOCIATE MEMBER, R. C. Davidson.

Squamish (Br. Non-Res.), ASSOCIATE MEMBERS, C. L. Bates, D. W. Hodsdon.

Trail (Br. Non-Res.), MEMBER, L. A. Campbell; ASSOCIATE MEMBERS, S. C. Montgomery, A. C. Ridgers, H. Vickers; JUNIOR, C. A. Broderick; STUDENTS, J. E. Craster, W. N. Papoff, R. J. Whitehouse.

Vancouver (Br. Res.), MEMBERS, W. Anderson, W. R. Bonnycastle, C. Brakenridge, P. P. Brown, P. H. Buchan, E. E. Carpenter, E. F. Carter, C. E. Cartwright, E. A. Cleveland, A. D. Creer, C. R. Crysdale, A. C. Eddy, A. E. Foreman, H. W. Frith, A. S. Gentles, G. M. Gilbert, H. Gisborne, J. R. Grant, J. P. Hodgson, N. J. Ker, W. L. Ketchen, F. Lee, D. O. Lewis, W. O. Marble, J. G. MacGregor, F. L. Macpherson, H. B. Muckleston, W. G. Murrin, W. H. Powell, H. Rindal, J. Robertson, W. Smaill, F. C. Stewart, L. Stockett, W. G. Swan, S. H. Sykes, E. C. Thrupp, G. A. Walkem, C. E. Webb, E. A. Wheatley, T. H. White, A. S. Wootton, A. C. R. Yuill; ASSOCIATE MEMBERS, H. P. Archibald, T. V. Berry, R. T. Blair, W. W. Brumby, J. E. Buerk, F. P. V. Cowley, A. W. G. Clark, W. R. Duckworth, W. P. Ferguson, H. C. Fitz-James, C. B. Freeman, W. B. Greig, C. T. Hamilton, J. B. Holdcroft, W. E. Jenkins, R. J. Lecky, J. McHugh, A. H. Macfarlane, J. P. Mackenzie, R. G. MacKenzie, H. N. Macpherson, F. O. Orr, J. B. Parham, A. Peebles, T. E. Price, R. Rome, P. Sandwell, P. M. Smith, W. O. Scott, G. L. Tooker, D. P. Urry, J. A. Walker, S. F. Workman, G. R. Wright; JUNIORS, C. R. Cornish, E. G. Cullwick, F. A. Forward, W. A. Madeley, R. C. Robson, W. H. Sparks; STUDENTS, E. Abernethy, D. E. Bell, E. R. Carswell, C. W. Deans, C. W. E. Locke, J. E. Macdonald, F. R. Phillips, J. A. Pike, A. G. Raue, J. M. Rothwell, H. L. Thorne, R. Walkem; AFFILIATE, G. E. Herrman.

Vernon (Br. Non-Res.), STUDENT, R. T. W. Allen.

Wells (Br. Non-Res.), STUDENT, T. H. Munn.

Williams Lake (Br. Non-Res.), ASSOCIATE MEMBER, W. Ramsay.

Woodfibre (Br. Non-Res.), ASSOCIATE MEMBERS, W. A. Bain, C. C. Ryan.

Yahk (Br. Non-Res.), STUDENTS, G. Eckenfelder, F. A. Lazenby.

Calgary Branch District

(*The territory in Alberta included between the north boundary of township thirteen from Saskatchewan to the British Columbia boundary, northerly on the interprovincial boundary to the north boundary of township forty-two; east to the east boundary of range twelve (west of the fourth meridian); south to the north boundary of township thirty-seven; east on the north boundary of township thirty-seven to the Saskatchewan boundary; and south on the interprovincial boundary to township thirteen.*)

Alexo (Br. Non-Res.), ASSOCIATE MEMBER, E. F. Pullen.

Banff (Br. Non-Res.), MEMBER, P. J. Jennings; ASSOCIATE MEMBER, C. K. LeCapelain.

Brooks (Br. Non-Res.), ASSOCIATE MEMBERS, H. G. Angell, C. C. Elliott.

Calgary (Br. Res.), MEMBERS, P. T. Bone, E. W. Bowness, M. P. Bridgland, F. G. Cross, A. S. Dawson, J. Dow, W. S. Fetherstonhaugh, A. Griffin, J. Haddin, R. C. Harris, D. W. Hays, O. H. Hoover, T. Lees, G. H. N. Monkman, J. H. Parks, S. G. Porter, F. M. Steel, J. S. Tempest, B. L. Thorne, J. R. Wood; ASSOCIATE MEMBERS, W. Anderson, E. Avery, F. G. Bird, G. P. F. Boese, R. L. Bonham, W. H. Broughton, A. S. Chapman, S. J. Davies, A. Dickson, F. S. Dyke, P. A. Fetterley, R. H. Goodchild, L. Green, J. J. Hanna, F. J. Heuperman, J. M. Ireton, M. W. Jennings, H. B. LeBourveau, A. W. P. Lowrie, A. T. McCormick, H. J. McEwen, W. T. McFarlane, R. Mackay, H. J. McLean, J. McMillan, W. St.J. Miller, H. H. Moore, V. A. Newhall, P. F. Peele, J. W. Reid, F. N. Rhodes, J. H. Ross, H. B. Sherman, G. H. Thompson, H. W. Tooker, D. T. Townsend, A. L. Tregillus, R. S. Trowsdale, J. H. Walshaw; JUNIORS, D. F. Becker, H. W. Becker, W. R. Davis, R. W. Dunlop, J. S. Neil, R. G. Paterson, W. A. Smith; STUDENTS, J. Blair, F. A. Brownie, A. C. Davidson, D. C. Fleming, A. W. Howard, E. Hulbert, C. L. Ingles, G. D. Kellam, G. G. D. Robertson.

Canmore (Br. Non-Res.), ASSOCIATE MEMBER, C. S. Dewis.

Didsbury (Br. Non-Res.), STUDENT, W. G. Sharp.

Exshaw (Br. Non-Res.), ASSOCIATE MEMBER, V. C. Hamilton.

High River (Br. Non-Res.), STUDENT, T. D. Stanley.

Nordegg (Br. Non-Res.), ASSOCIATE MEMBER, A. Cox.

Okotoks (Br. Non-Res.), STUDENT, D. V. McIntyre.

Patricia (Br. Non-Res.), ASSOCIATE MEMBER, H. B. Miller.

Seebe (Br. Non-Res.), JUNIOR, I. A. Abramson.

Strathmore (Br. Non-Res.), MEMBER, E. N. Ridley; ASSOCIATE MEMBERS, G. H. Patrick, T. Schulte.

Turner Valley (Br. Non-Res.), MEMBER, S. G. Coultis; STUDENT, J. E. Beach.

Edmonton Branch District

(*All the Province of Alberta north of the northern boundary of the Calgary Branch.*)

Alcomdale (Br. Non-Res.), JUNIOR, P. Hargrove.

Edmonton (Br. Res.), MEMBERS, J. D. Baker, F. K. Beach, J. Callaghan, L. C. Charlesworth, W. J. Dick, J. Garrett, A. J. Gayfer, R. J. Gibb, H. J. MacLeod, W. R. Mount, A. I. Payne, C. A. Robb, E. Stansfield, R. S. L. Wilson; ASSOCIATE MEMBERS, J. M. Anderson, H. A. Bowden, T. W. Brown, J. W. S Chappelle, W. E. Cornish, R. M Dingwall, J. H. W. Douglas, J. M. Forbes, M. L. Gale, C. E. Garnett, A. W. Haddow, D. A. Hansen, H. P. Keith, E. Nelson, V. Pearson, A. Ritchie, R. W. Ross, R. H. Stevens, W. G. Stuart, H. H. Tripp, H. R. Webb, T. H. White; JUNIORS, H. R. M. Acheson, R. M. Hardy, J. W. Porteous; STUDENTS, J. E. Cranswick, J. C. Dale, L. J. Ehly, E. R. Gayfer, W. J. Gold, W. G. Hole, H. L. Hurdle, K. A. Jackson, W. L. Kent, J. F. McDougall, R. C. McPherson, B. W. Pitfield, W. L. Redmond, G. Sinclair, E. L. Smith, R. L. Stevens, N. O. Weston, J. Woznow, F. J. Wyllie.

Jasper (Br. Non-Res.), MEMBER, A. C. Wright.

Manola (Br. Non-Res.), ASSOCIATE MEMBER, H. J. Whittaker.

Mayerthorpe (Br. Non-Res.), ASSOCIATE MEMBER, E. Hughes.

Peace River (Br. Non-Res.), ASSOCIATE MEMBER, J. H. Johnston.

Spedden (Br. Non-Res.), JUNIOR, J. P. Svarich.

St. Paul de Metis (Br. Non-Res.), MEMBER, M. W. Hopkins.

Sterco (Br. Non-Res.), ASSOCIATE MEMBER, W. F. Stevenson.

Vegreville (Br. Non-Res.), STUDENTS, J. G. MacGregor, E. H. Perlson.

Vermilion (Br. Non-Res.), ASSOCIATE MEMBER, B. E. Bury.

Lethbridge Branch District

(*The territory in Alberta and British Columbia included between the United States boundary from Saskatchewan to the 117th degree of longitude in British Columbia; north to the 50th parallel; east to the Alberta boundary; northerly on the interprovincial boundary to the north boundary of township thirteen in Alberta, east to the Saskatchewan boundary, and south on the interprovincial boundary to the United States boundary.*)

Coal Creek, B.C. (Br. Non-Res.), STUDENT, W. R. Workman.

Coaldale (Br. Res.), ASSOCIATE MEMBERS, R. S. Lawrence, H. W. Rowley.

Coalhurst (Br. Res.), ASSOCIATE MEMBER, D. H. Quigley.

Diamond City (Br. Res.), ASSOCIATE MEMBER, C. S. Clendening.

Etzikom (Br. Non-Res.), STUDENT, R. C. Davis.

Fernie, B.C. (Br. Non-Res.), ASSOCIATE MEMBER, G. E. Elkington.

Kimberley, B.C. (Br. Non-Res.), ASSOCIATE MEMBER, A. B. Ritchie; JUNIOR, G H. Morrison.

Lethbridge (Br. Res.), MEMBERS, J. B. deHart, G. N. Houston, R. Livingstone, P. M. Sauder; ASSOCIATE MEMBERS, R. F. P. Bowman, N. H. Bradley, G. S. Brown, J. M. Campbell, C. S. Donaldson, J. Haimes, W. L. McKenzie, S. F. McLeod, W. Meldrum, A. Thomson, J. T. Watson; STUDENTS, J. A. Burke, W. R. Craig, J. E. Hawkins, E. A. Lawrence, R. B. McKenzie.

Magrath (Br Res.), ASSOCIATE MEMBER, M. F. R Lloyd.

Medicine Hat (Br. Non-Res.), ASSOCIATE MEMBERS, A. C. Gardner, C. M. Moore; STUDENT, H. R. Hayes.

Monarch (Br. Res.), STUDENT, A. P. Alexander.

Picture Butte (Br. Res.), ASSOCIATE MEMBER, A. J. Branch.

Rainier (Br. Non-Res.), JUNIOR, W. Crook.

Saskatchewan Branch District

(*The Province of Saskatchewan.*)

Borden (Br. Non-Res.), STUDENT, D. Lazorka.

Carlyle (Br. Non-Res.), ASSOCIATE MEMBER, W. E. Denley.

Claybank (Br. Non-Res.), ASSOCIATE MEMBER, S. Matthews.

Dunblane (Br. Non-Res.), STUDENT, C. R. Forsberg.

Dundurn (Br. Non-Res.), Associate Members, W. P. Dempsey, C. J. L. Sanderson; Student, C. F. Dobson-Smith.

Hillmond (Br. Non-Res.), Student, W. C. Newman.

Indian Head (Br. Non-Res.), Student, A. H. Douglas.

Island Falls (Br. Non-Res.), Junior, E. C. King; Affiliate, H. T. Olson.

Kamsack (Br. Non-Res.), Associate Member, J. M. Bloomfield.

Lloydminster (Br. Non-Res.), Associate Member, S. E. Durant.

Lydden (Br. Non-Res.), Student, C. C. Schnedar.

Maple Creek (Br. Non-Res.), Member, W. W. Meadows.

Melville (Br. Non-Res.), Associate Member, H. M. Bailey.

Moose Jaw (Br. Non-Res.), Member, H. R. Miles; Associate Members, H. J. A. Bird, H. C. Ritchie; Junior, N. R. Crump.

Nipawin (Br. Non-Res.), Associate Member, N. A. Link.

North Battleford (Br. Non-Res.), Member, A. E. Sharpe.

Pelly (Br. Non-Res.), Student, W. Trischuk.

Prince Albert (Br. Non-Res.), Members, W. Christie, J. G. Reid.

Punnichy (Br. Non-Res.), Associate Member, S. Harding.

Regina (Br. Res.), Members, H. S. Carpenter, J. N. deStein, J. W. D. Farrell, A. C. Garner, A. P. Linton, D. A. R. McCannel, M. H. Marshall, P. C. Perry, L. A. Thornton, S. Young; Associate Members, R. W. Allen, E. S. C. Carpenter, D. C. M. Davies, E. A. Duschak, W. G. Dyer, G. G. Fitzgerald, R. J. Fyfe, P. R. Genders, W. H. Hastings, R. W. Jickling, H. A. Jones, E. E. Lord, P. G. McAra, C. J. McGavin, H. R. MacKenzie, J. C. Meade, S. R. Muirhead, R. H. Murray, J. M. Patton, J. H. Puntin, F. B. Reilly, H. L. Roblin, J. K. Sexton, M. J. Spratt, T. G. Tyrer, J. J. White; Juniors, A. F. S. Fuller, L. W. Llewellyn; Students, A. W. Braine, N. I. Fraser, G. B. Greene, L. M. Howe, W. N. McCann, J. E. Thom, J. Walter.

Ridgedale (Br. Non-Res.), Student, Z. Levington.

Rosetown (Br. Non-Res.), Associate Member, J. C. Todd.

Saskatoon (Br. Non-Res.), Members, A. R. Greig, C. J. Mackenzie, W. G. Worcester; Associate Members, I. M. Fraser, W. E. Lovell, A. M. Macgillivray, R. A. Spencer, G. M. Williams; Juniors, E. J. Durnin, F. J. E. Martin, E. K. Phillips.

Swift Current (Br. Non-Res.), Member, B. Russell; Juniors, J. C. Aitkens, F. L. Grindley.

Theodore (Br. Non-Res.), Student, G. S. Anderson.

Tisdale (Br. Non-Res.), Student, J. E. Mollard.

Weyburn (Br. Non-Res.), Associate Member, H. J. deSavigny.

Yorkton (Br. Non-Res.), Associate Member, M. Sinclair.

Winnipeg Branch District

(*The Province of Manitoba.*)

Ashern (Br. Non-Res.), Student, L. J. Marshall.

Boissevain (Br. Non-Res.), Associate Member, J. A. Wakefield.

Brandon (Br. Non-Res.), Member, W. H. Shillinglaw; Associate Members, J. P. Fraser, T. J. Pounder, S. C. Wilcox.

Brunkild (Br. Non-Res.), Associate Member, F. E. Umphrey.

Churchill (Br. Non-Res.), Associate Members, G. Coutts, G. Kydd, W. L. Mackenzie.

Cranberry Portage (Br. Non-Res.), Member, W. T. Thompson.

Dauphin (Br. Non-Res.), Associate Member, R. C. Robinson.

Flin Flon (Br. Non-Res.), Juniors, W. L. Bunting, L. W. McClure; Students, R. H. Moore, M. K. T. Reikie.

Fort Whyte (Br. Res.), Associate Member, C. W. Edmonds.

Garson (Br. Non-Res.), Associate Member, C. H. Blanchard.

God's Lake (Br. Non-Res.), Associate Member, W. M. Reynolds.

Lydiatt (Br. Non-Res.), Member, W. A. James.

Lyleton (Br. Non-Res.), Junior, W. G. Reekie.

Morden (Br. Non-Res.), Junior, R. A. Emerson.

Norwood (Br. Res.), Associate Member, F. B. Hazel; Student, R. P. Fraser.

Pointe du Bois (Br. Non-Res.), Junior, T. E. Storey.

Reston (Br. Non-Res.), Associate Member, D. A. Livingston.

St. Boniface (Br. Res.), Junior, W. R. C. Taylor.

Selkirk (Br. Res.), Student, C. H. Martin.

Seven Sisters Falls (Br. Non-Res.), Associate Members, V. W. Dick, A. S. Williams.

The Pas (Br. Non-Res.), Associate Members, F. P. Fuller, J. G. MacLachlan.

Transcona (Br. Res.), Student, L. E. Jones.

Virden (Br. Non-Res.), Associate Members, H. D. Brydone-Jack, G. R. Hill.

Winckler (Br. Non-Res.), Student, H. F. Peters.

Winnipeg (Br. Res.), Members, F. W. Alexander, W. P. Brereton, W. Burns, E. V. Caton, C. H. Dancer, J. A. Douglas, L. L. Doupe, C. Ewart, E. P. Fetherstonhaugh, J. N. Finlayson, A. W. Fosness, C. H. Fox, F. G. Goodspeed, N. M. Hall, H. B. Henderson, G. H. Herriot, J. C. Holden, T. Kipp, D. A. MacDougall, W. M. Macphail, W. A. Mather, V. Michie, E. R. Millidge, J. W. Porter, D. A. Ross, W. M. Scott, F. V. Seibert, D. N. Sharpe, A. J. Sill, J. G. Sullivan, F. B. Tapley, J. Woodman; Associate Members, G. Affleck, R. H. Andrews, C. H. Attwood, C. T. Barnes, E. A. Beman, H. B. Brehaut, F. M. Brickenden, H. C. D. Briercliffe, H. L. Briggs, A. Campbell, G. W. Campbell, V. H. Campbell, A. L. Cavanagh, J. L. Charles, G. Clark, C. A. Clendening, G. E. Cole, J. F. Cunningham, H. A. Dixon, J. E. Duncan, J. H. Edgar, E. G. Eggertson, F. S. Fowler, W. Fulton, J. Gordon, J. L. Gordon, F. F. Griffin, C. H. Gunn, C. P. Haltalin, S. G. Harknett, B. Henderson, W. E. Hobbs, B. B. Hogarth, L. M. Hovey, W. D. Hurst, E. W. M. James, V. C. Jones, C. E. Joslyn, E. S. Kent, T. H. Kirby, A. M. Kirkpatrick, H. C. G. Ligertwood, C. R. Lys, G. B. McColl, S. E. McColl, G. McDermid, A. E. Macdonald, J. A. MacGillivray, W. J. MacKenzie, R. W. McKinnon, D. L. McLean, H. W. McLeod, T. C. Main, R. W. Moffatt, W. F. Oldham, A. W. Paterson, E. B. Patterson, G. M. Pearston, J. D. Peart, W. D. Pender, B. L. Reid, E. M. Rensaa, J. T. Rose, J. D. Ruttan, J. W. Sanger, G. L. Shanks, H. L. Sherwood, D. M. Stephens, D. G. Sutherland, A. J. Taunton, A. Taylor, J. C. Trueman, J. Veitch, W. Walkden, A. S. Weekes, H. M. White, J. Young; Juniors, E. W. R. Butler, H. D. Cluff, J. L. McMahon, H. Payne, W. F. Riddell, J. B. Striowski, C. J. Timleck; Students, C. V. Antenbring, G. S. Baldry, E. S. Braddell, N. S. Bubbis, W. A. Capelle, A. B. Connelly, A. G. Courtney, B. H. Darwin, D. M. Dunlop, E. Gauer, G. H. Griffiths, T. L. Hall, E. L. Hartley, R. P. Henderson, W. C. Houghton, J. Howorth, M. Levin, K. Y. Lochhead, E. R. Love, G. M. Lyon, J. R. Mathieson, D. W. Miller, W. R. Mitchell, H. Nelson, L. G. Scott, H. G. Seybold, C. G. Wallman, D. H. Watson, F. Willows, T. L. Woodhall; Affiliate, W. Hurst.

ZONE B

(*The Province of Ontario*)

Lakehead Branch District

(*The Counties of Kenora, Thunder Bay, Rainy River, Patricia.*)

Dryden (Br. Non-Res.), Member, J. S. Wilson; Junior, H. J. Petursson.

Fort Francis (Br. Non-Res.), Associate Member, W. B. Hutcheson.

Fort William (Br. Res.), Member, P. E. Doncaster; Associate Members, G. P. Brophy, G. R. Duncan, K. A. Dunphy, H. G. O'Leary, C. B. Symes; Students, J. I. Carmichael, G. G. DeMocko, G. R. Duncan.

Gold Pines (Br. Non-Res.), Associate Member, F. C. Rust.

Hawk Lake (Br. Non-Res.), Associate Member, F. Petursson.

Hudson (Br. Non-Res.), Associate Member, G. G. McEwen.

Ignace (Br. Non-Res.), Associate Member, F. D. Austin.

Kenora (Br. Non-Res.), Members, E. A. Kelly, C. D. MacKintosh; Associate Members, J. F. Lester, J. A. McCoubrey, J. R. Paget; Junior, R. O. Paulsen.

Nakina (Br. Non-Res.), Associate Member, W. E. Harry.

Port Arthur (Br. Res.), Members, J. Antonisen, G. H. Burbidge, R. B. Chandler, C. D. Howe; Associate Members, R. J. Askin, E. J. Bolger, B. A. Culpeper, G. Eriksen, J. M. Fleming, E. L. Goodall, F. C. Graham, G. R. McLennan, H. Os; Students, W. H. Peach, J. A. Rogers.

Red Lake (Br. Non-Res.), Student, G. L. Hood.

Root River Portage (Br. Non-Res.), Associate Member, C. M. Low.

Schreiber (Br. Non-Res.), Associate Member, W. W. Benny; Student, W. R. Benny.

Sioux Lookout (Br. Non-Res.), Associate Member, H. A. Oaks.

White River (Br. Non-Res.). Associate Member. W. J. Bishop.

Sault Ste. Marie Branch District

(*The Counties of Algoma, Cochrane, Nipissing (north of the Mattawa River), Sudbury (including Manitoulin Island), Timiskaming, Ont., and the area in the United States within a radius of twenty-five miles of Sault Ste. Marie.*)

Blind River (Br. Non-Res.), Student, J. R. Carter.

Copper Cliff (Br. Non-Res.), Members, R. L. Peek, J. F. Robertson, W. J. Ripley; Associate Member, C. O. Maddock.

Falconbridge (Br. Non-Res.), Associate Members, K. E. Buchmann, E. W. Neelands; Juniors, J. Hunt, T. S. Mathieson.

Haileybury (Br. Non-Res.), Member, J. W. Morrison.

Kapuskasing (Br. Non-Res.), Associate Members, C. W. Boast, C. R. Murdock; Juniors, T. Foulkes, D. N. McCormack, G. M. Minard.

Kirkland Lake (Br. Non-Res.), Member, W. T. Sampson; Junior, J. H. Brumell; Student, J. G. Stephenson.

Lochalsh (Br. Non-Res.), Junior, G. E. Humphries.

New Liskeard (Br. Non-Res.), Associate Members, J. G. M. Baxter, G. E. Booker, F D. Gifford, M. B. Saunders, H. W. Sutcliffe; Junior, H. L. Hewitt; Students, T. B. Fraser, W. M. Harvey.

North Bay (Br. Non-Res.), Members, S. B. Clement, C. H. N. Connell, S. B. McConnell, W. T. Moodie; Associate Members, R. G. Boast, W. N. Cann, W. O. Collis, L. M. Duclos, T. J. Moore; Student, W. F. Miller.

Sault Ste. Marie (Br. Res.), Members, H. F. Bennett, J. D. Jones, J. L. Lang, R. S. McCormick, A. E. Pickering, J. W. LeB. Ross, K. G. Ross, W. Seymour, F. Smallwood, C. Stenbold; Associate Members, O. L. J. Brauns, H. O. Brown, LeR. Brown, R. A. Campbell, C. W. Holman, J. H. Jenkinson, E. M. MacQuarrie, A. H. Russell, C. J. Russell; Juniors, R. H. Burns, N. C. Cowie, O. A. Evans, F. A. Masse, A. M. Wilson; Student, E. F. Brown.

Schumacher (Br. Non-Res.), Member, A. D. Campbell; Associate Member, R. D. H. Wigmore; Student, W. G. Cosser.

Smooth Rock Falls (Br. Non-Res.), Student, V. Oleskevich.

South Porcupine (Br. Non-Res.), Member, H. P. DePencier; Student, G. D. Wagner.

Sturgeon Falls (Br. Non-Res.), Associate Member, G. W. Holder.

Sudbury (Br. Non-Res.), Associate Members, L. A. B. Hutton, H. J. Kurtz, W. L. Langlois, A. M. Mills, W. S. E. Morrison, F. A. Orange; Student, L. O. Cooper.

Timmins (Br. Non-Res.), Associate Members, W. G. Heslop, H. Idsardi, A. A. Rose; Juniors, P. L. Climo, F. D. Greenwood; Students, B. R. Heavysege, L. A. A. Prete, H. R. Rice, A. E. C. Schneller.

Border Cities Branch District

(*The Counties of Essex, Kent, Lambton, and the area in the United States within a radius of twenty-five miles of Windsor.*)

Amherstburg (Br. Non-Res.), Associate Member, W. M. Mitchell; Student, R. J. G. Schofield.

Chatham (Br. Non-Res.), Member, G. A. McCubbin; Associate Members, T. M. S. Kingston, C. K. S. Macdonell; Junior, W. L. Dutton; Student, R. M. Nicholson.

Detroit, Mich. (Br. Res.), Member, F. C. McMath; Associate Members, J. H. Bradley, W. J. Campbell, H. J. Coulter, A. McWilliam.

East Windsor (Br. Res.), Associate Member, J. E. Porter.

Leamington (Br. Non-Res.), Student, J. C. Elliott.

Ojibway (Br. Res.), Member, W. H. Baltzell.

Sandwich (Br. Res.), Associate Members, B. Candlish, C. F. Davison, T. H. Jenkins, C. G. Walton; Student, W. R. McColl.

Sarnia (Br. Non-Res.), Members, J. A. Baird, T. Montgomery; Associate Members, J. W. MacDonald, E. M. Salter, M. L. Walker; Junior, C. P. Warkentin; Student, O. B. Mason.

Walkerville (Br. Res.), Members, P. E. Adams, D. T. Alexander, C. M. Goodrich, F. H. Kester, S. E. McGorman, R. A. Spencer, E. A. Stone, A. E. West; Associate Members, J. G. Campbell, H. J. A. Chambers, G. V. Davies, W. A. Dawson, E. M. Krebser, R. C. Leslie, H. W. Patterson, J. W. Seens, F. Stevens; Students, B. A. Berger, E. Chorolsky, W. H. Kester.

Windsor (Br. Res.), Members, J. J. Newman, O. M. Perry; Associate Members, C. G. R. Armstrong, A. J. M. Bowman, J. F. Bridge, J. E. Daubney, W. J. Fletcher, J. C. Keith, V. W. MacIsaac, G. E. Medlar, O. Rolfson, A. T. E. Smith, G. C. Storey; Junior, G. W. Lusby; Students, C. Macdonald, F. J. Ryder; Affiliate, C. P. Sale.

London Branch District

(*The Counties of Elgin, Middlesex, Oxford, Perth, Huron, Bruce.*)

Glencoe (Br. Non-Res.), Junior, W. G. Richardson.

Hensall (Br. Non-Res.), Associate Member, H. G. Rose.

Ingersoll (Br. Non-Res.), Junior, N. Allen.

London (Br. Res.), Members, S. W. Archibald, H. A. Brazier, E. V. Buchanan, H. B. R. Craig, I. Leonard, A. H. Morgan, A. O. Wolff; Associate Members, F. C. Ball, D. M. Bright, J. Ferguson, R. W. Garrett, H. L. Hayman, S. G. Johre, H. A. McKay, V. A. McKillop, J. R. Rostron, D. S. Scrymgeour, W. R. Smith, C. Talhot, W. M. Veitch; Junior, J. L. McDougall; Students, G. R. Davidson, G. J. Forristal, C. H. Hillier, B. Simmons, D. L. Tait.

St. Mary's (Br. Res.), Associate Member, C. E. Richardson.

St. Thomas (Br. Res.), Member, W. C. Miller; Associate Members, F. A. Bell, W. Dalziel, S. B. Wass; Students, F. J. Benjafield, G. Benjafield.

Stratford (Br. Non-Res.), Members, S. A. Cummiford, A. B. Manson; Associate Members, W. E. Plummer, W. H. Riehl; Junior, A. F. Flintoff.

Strathroy (Br. Non-Res.), Associate Member, D. G. Calvert.

Tillsonburg (Br. Non-Res.), Member, C. V. Corless; Associate Member, G. Rankin.
Walkerton (Br. Non-Res.), Associate Member, G. E. Stephenson.
Woodstock (Br. Res.), Associate Members, J. Carnwath, F. T. Julian, W. G. Ure, J. A. Vance.

Hamilton Branch District

(The Counties of Wentworth, Norfolk, Brant, Waterloo, Halton West (Townships of Nelson and Nassagaweya), Wellington, Haldimand.)

Ancaster (Br. Res.), Member, P. Ford-Smith.
Brantford (Br. Res.), Members, H. E. Mott, C. A. Waterous; Associate Members, F. P. Adams, C. F. Cockshutt.
Burlington (Br. Res.), Associate Members, C. E. Hogarth, E. L. Zealand.
Dundas (Br. Res.), Member, H. G. Bertram; Junior, M. W. Huggins; Students, J. E. Gordon, L. S. Lauchland, W. M. Robinson; Affiliate, J. F. Crowley.
Fergus (Br. Non.Res.), Student, J. A. Fisher.
Galt (Br. Res.), Student, E. B. Hymmen.
Guelph (Br. Non-Res.), Members, L. E. Jones, F. MeArthur; Associate Members, E. P. Bowman, W. H. Keith, H. S. Nicklin; Student, D. R. McQueen.
Hagersville (Br. Non-Res.), Student, J. S. Green.
Hamilton (Br. Res.), Members, W. D. Black, J. B. Carswell, G. A. Colhoun, E. H. Darling, L. W. Gill, H. U. Hart, W. G. Hewson, W. Hollingworth, F. I. Ker, R. L. Latham, A. Love, H. A. Lumsden, J. A. McFarlane, W. L. McFaul, J. J. Mackay, W. F. McLaren, C. D. Meals, W. G. Milne, E. P. Muntz, R. K. Palmer, F. W. Paulin, A. T. Perrin, H. S. Philips, H. A. Ricker, J. Stodart, H. B. Stuart, J. W. Tyrrell; Associate Members, G. W. Arnold, G. M. Bayne, R. E. Butt, D. W. Callander, E. M. Coles, W. H. Collins, E. D. W. Courtice, J. R. Dunbar, H. M. Fletcher, W. B. Ford, T. S. Glover, J. P. Gordon, E. Haggas, A. R. Hannaford, F. W. Hubbard, F. R. Leadley, O. E. Leger, E. G. MacKay, W. L. Miller, G. Moes, J. C. Nash, W. J. W. Reid, A. G. Riddell, F. L. Smith, V. S. Thompson, W. W. Van Every, N. Wagner, C. W. Webster, C. F. Whitton; Juniors, W. E. Brown, A. B. Dove, G. G. Gates, W. A. T. Gilmour, A. F. McPherson, A. Pottinger, C. C. Smith, W. J. Thomson, J. T. Thwaites; Students, S. M. Baker, G. M. Bell, D. E Bridge, L. S. Collison, H. G. Conn, H. P. Dickey, J. L. Donaldson, R. A. Harvie, E. C. Hay, J. R. Hutton, A. E Hyde, E. P. N. Innes, G. W. Jarvis, D. B. Leightner, J. E. McClung, W. L. McKiel, H. F. McLachlan, G. Pilkey, W. W. Preston, R. W. Price, A. G. Scobie, R. N. Tucker, A. J. Turner, D. W. Wood; Affiliate, J. A. M. Galilee.
Kitchener (Br. Non-Res.), Members, W. H. Breithaupt, S. Shupe; Associate Members, C. L. Breithaupt, P. W. Breithaupt, E. L. Dilworth, D. J. Emrey, M. Pequegnat; Juniors, G. R. Beavers, W. M. Prudham; Students, J. H. Gregory, L. D. McGee, J. M. Pequegnat.
Preston (Br. Non-Res.), Member, F. H. Midgley.
Simcoe (Br. Non-Res.), Associate Members, C. H. Donnelly, J. F. LaPlant, G. R. Marston.
Waterloo (Br. Non-Res.), Associate Member, A. M. Snider.

Niagara Peninsula Branch District

(The Counties of Lincoln, Welland, and the area in the United States within a radius of twenty-five miles of Niagara Falls, Ontario.)

Buffalo, N.Y. (Br. Non-Res.), Member, N. R. Gibson; Associate Members, J. D. Burbank, H. D. Fyfe.
Chippawa (Br. Res.), Associate Member, G. C. Mountford.
Fort Erie (Br. Res.), Member, C. H. Scheman.
Fort Erie North (Br. Res.), Associate Members, C. S. Boyd, L. C. McMurtry, W. R. Manock.
Grimsby (Br. Non-Res.), Associate Member, G. F. Hanning.
Niagara Falls, N.Y. (Br. Res.), Member, C. J. H. Moritz; Associate Member, J. H. Legg; Student, A. C. Knapp.
Niagara Falls, Ont. (Br. Res.), Members, H. G. Acres, H. L. Bucke, R. L. Hearn. J. H. Jackson, W. Jackson, H. M. King; Associate Members, T. A. Barnett, J. R. Bond, W. D. Bracken, C. G. Cline, G. H. E. Dennison, P. A. Dewey, A. M. Fennis, L. L. Gisborne, M. F. Ker, J. M. Kilkenny, A. A. McLaren, A. W. F. McQueen, J. L. Miller, W. B. Musgrave, G. H. Wood; Junior, A. M. MacDonald; Students, K. L. Bellamy, F. S. Durdan, G. D. Durham, L. A. Hilton.
Port Colborne (Br. Res.), Associate Members, C. N. Geale, E. C. Little, E. P. Murphy; Junior, A. C. Harvie.
Port Robinson (Br. Res.), Associate Member, J. E. Sears.
Ridgeway (Br. Non-Res.), Student, A. C. Ellsworth.
St. Catharines (Br. Res.), Members, M. B. Atkinson, A. J. Grant, L. P. Rundle, F. E. Sterns, W. H. Sullivan, G. F. Vollmer; Associate Members, A. C. Blue, R. A. Bradley, E. G. Cameron, H. M. Campbell, W. Campion, H. S. Clark. J. V. Fahey, E. Grummitt, S. Hairsine, A. G. Herr, F. C. Jewett, M. H. Jones, R. V. H. Keating, J. B. McAndrew, A. L. McPhail, H. C. Maguire, C. G. Moon, J. C. Moyer, A. H. Perry, W. T. Porter, C. W West; Junior, J. F. Shelton; Student, D. D. Hall.
Thorold (Br. Res.), Associate Members, S. Bowen, P. E. Buss, G. E. Griffiths, C. B. Shaw.

Welland (Br. Res.), Members, F. L. Haviland, G. Morrison, J. C. Street, H. Wellwood; Associate Members, C. H. M. Burns, N. K. Cameron, E. P. Johnson, J. Stephenson; Student, R. T. Sawle.

Toronto Branch District

(The Counties of Ontario, York, Peel, Halton East (Townships of Trafalgar and Esquesing), Dufferin, Grey, Simcoe, Muskoka, Parry Sound, Nipissing (south of Mattawa River).)

Aurora (Br. Res.), Student, C. G. Southmayd.
Barrie (Br. Non-Res.), Associate Member, J. Walker.
Birch Cliff (Br. Res.), Associate Member, R. Harrison.
Brampton (Br. Res.), Associate Member, W. P. Dale.
Burk's Falls (Br. Non-Res.), Student, W. V. Rintoul.
Camp Borden (Br. Non-Res.), Associate Member, D. C. M. Hume; Juniors, W. O. Peffers, W. S. Wishart; Students, C. R. Dunlap, H. B. Godwin, M. M. Hendrick, A. C. Herbert, E. A. McGowan, D. E. McIntosh, D. G. Williams.
Clarkson (Br. Res.), Member, A. S. Cook.
Emsdale (Br. Non-Res.), Associate Member, J. H. Ings.
Forest Hill Village (Br. Res.), Associate Member, G. Alison; Student, B. B. Puddy.
Lakeview (Br. Res.), Member, H. M. Cawthra-Elliot.
Leaside (Br. Res.), Member, H. Horsfall; Associate Member, J. R. Roberts; Junior, W. H. Hooper.
Long Branch (Br. Res.), Associate Member, J. S. Galletley; Junior, J. A. C. Bowen.
Mono Road (Br. Res.), Associate Member, J. E. Hinchliffe.
Mount Dennis (Br. Res.), Member, A. B. Cooper.
Nobel (Br. Non-Res.), Student, R. B. Carpenter.
Oakville (Br. Res.), Member, C. Johnston; Associate Member, C. Connell.
Orillia (Br. Non-Res.), Associate Member, L. G. McNeice.
Oshawa (Br. Non-Res.), Associate Member, F. Chappell; Student, W. O. Hart.
Owen Sound (Br. Non-Res.), Associate Members, N. Bowman, T. D. Kennedy, R. McDowall, R. C. McKnight.
Pickering (Br. Res.), Member, W. A. McLean.
Port Carling (Br. Non-Res.), Student, K. W. MacDermott.
Port Elgin (Br. Non-Res.), Junior, C. G. E. Feick.
Sheridan (Br. Non-Res.), Student, S. N. Lawrence.
Stouffville (Br. Non-Res.), Student, M. R. Lemon.
Sundridge (Br. Non-Res.), Associate Member, T. J. Paget.
Toronto (Br. Res.), Members, A. Aeberli, E. A. Allcut, J. R. W. Ambrose, R. W. Angus, H. W. D. Armstrong, T. S. Armstrong, R. A. Baldwin, J. H. Barber, F. J. Bell, A. E. Berry, A. W. K. Billings, H. A. Bodwell, W. E. Bonn, A. E. K. Bunnell, W. G. Chace, W. P. Chapman, F. G. Clark, J. R. Cockburn, A. W. Connor, E. L. Cousins, C. R. Coutlee, A. B. Crealock, E. A. Cross, C. J. Crowley, A. G. Dalzell, V. A. G. Dey, L. S. Dixon, W. P. Dobson, F. C. Dyer, F. R. Ewart, R. Fleming, D. M. Fraser, A. M. German, G. Grant, J. Grieve, C. B. Hamilton, A. H. Harkness, D. W. Harvey, H. E. T. Haultain, S. E. M. Henderson, M. C. Hendry, C. S. L. Hertzberg, E. G. Hewson, G. Hogarth, T. H. Hogg, J. Hole, A. R. Holmes, L. M. Jones, J. G. G. Kerry, A. A. Kinghorn, J. A. Knight, H. J. Lamb, L. A. C. Lee, T. R. Loudon, H. W. McAll, W. Maclachlan, A. T. C. McMaster, J. A. McNicol, N. MacNicol, D. Macpherson, H. G. McVean, C. H. Mitchell. E. V. Moore, J. L. Morris, A. L. Mudge, W. P. Near, I. H. Nevitt, L. R. 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Malin (Br. Non-Res.), Student, A. M. S. Jones.

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Pointe-au-Pic (Br. Non-Res.), Associate Member, H. Warren.

Portneuf (Br. Non-Res.), Associate Member, C. A. Buchanan.

Quebec (Br. Res.), Members, G. K. Addie, H. Cimon, F. T. Cole, A. R. Decary, J. A. Duchastel, A. O. Dufresne, E. A. Evans, A. Gratton, J. F. Guay, C. V. Johnson, L. B. Kingston, A. Lariviere, J. A. Lefebvre, A. A. MacDiarmid, J. O. Martineau, J. O. Montreuil, A. B. Normandin, A. Paradis, J. Ruddick; Associate Members, A. W. Ahern, A. Amos, J. U. Archambault, L. B. Beaudry, J. L. Bizier, C. H. Boisvert, T. J. Boivin, M. Boyer, W. S. Bucbanan, W. R. Caron, G. H. Cartwright, R. E. Cumming, T. M. Dechene, O. Desjardins, J. H. A. E. Drolet, A. V. Dumas, P. A. Dupuis, R. Dupuis, L. E. Ennis, R. H. Farnsworth, L. Gagnon, E. D. Gray-Donald, M. L. Guimont, H. E. Huestis, J. P. P. Joncas, J. Joyal, A. J. Kerry, T. J. F. King, Z. Langlais, E. Laurence, C. C. Lessard, J. C. Longstaff, R. B. McDunnough, P. Marcotte, L. Martin, P. Méthé, C. Milot, G. Molleur, J. G. O'Donnell, J. O'Halloran, S. S. Oliver, G. C. Piche, W. R. G. Ray, A. Roberge, J. E. Roy, A. G. Sabourin, R. Sauvage, R. J. L. Savary, D. S. Scott, A. Smith, J. A. Smith, A. Tremblay, T. L. Tremblay, I. E. Vallee, S. J. H. Waller, R. Wood; Junior, F. A. Price; Stunents, M. G. Archer, G. Lemieux, W. J. Manning, P. R. Rolleston. J. Saint-Jacques, G. A. Verge, J. Winn; Affiliate, A. Paradis.

Rapide Blanc (Br. Non-Res.), Stuent, A. H. Watier.

Rimouski (Br. Non-Res.), Associate Member, L. G. Trudeau; Stuent, P. Warren.

St. Anselme, Student, P. E. Cadrin.

Valcartier (Br. Res.), Associate Members, A. G. Ashford, C. B. Bate, G. D O'Connor.

Saguenay Branch District

(*The Counties of Saguenay, Chicoutimi, Lake St. John.*)

Arvida (Br. Res.), Associate Members, A. I. Cunningbam, J. R. Hango, A. C. Johnston, F. L. Lawton, C. Miller, R. H. Rimmer, M. G. Saunders, H. R. Wake, J. W. Ward, A. W. Whitaker, Jr.; Juniors, J. J. Fortin, R. Lanctot; Students, B. Bauman, F. T. Boutilier, F. Calder, W. E. Cooper.

Chicoutimi (Br. Res.), Member, E. Lavoie; Associate Members, R. Belanger, J. F. Grenon, J. L. Delisle, R. E. Joron, G. E. LaMothe, H. B. Pelletier.

Dolbeau (Br. Res.), Member, D. A. Evans; Associate Member, E. Cowan.

Kenogami (Br. Res.), Associate Members, A. Cunningham, J. Sbanly; Juniors, J. W. Gathercole, W. P. C. LeBoutillier, J. R. B. Milne, A. B. Sinclair; Stuent, L. R. Beatb.

Port Alfred (Br. Res.), Associate Member, J. C. H. Jette.
Riverbend (Br. Res.), Member, S. J. Fisher; Associate Members, G. H. Kirby, G. F. Layne, N. F. McCaghey.

ZONE D

(*The Maritime Provinces*)

Moncton Branch District

(*The Counties of Albert, Westmoreland, Kent, Northumberland, Restigouche, Gloucester, and the Province of Prince Edward Island.*)

Campbellton (Br. Non-Res.), Student, R. T. Sansom.
Charlottetown, P.E.I. (Br. Non-Res.), Members, W. E. Hyndman, E. L. Miles; Associate Members, E. S. Chandler, W. A. McLaren, H. E. Miller, A. Scott; Student, M. C. Archibald.
Chatham (Br. Non-Res.), Students, G. J. Hayes, R. F. Sadler.
Elgin (Br. Non-Res.), Student, R. Goddard.
Lewisville (Br. Non-Res.), Member, E. R. Evans.
Malpeque, P.E.I. (Br. Non-Res.), Junior, E. K. Macnutt.
Moncton (Br. Res.), Members, F. O. Condon, R. H. Findlater, H. T. Hazen; Associate Members, B. E. Bayne, V. C. Blackett, H. J. Crudge, G. L. Dickson, T. H. Dickson, R. H. Emmerson, J. R. Freeman, F. B. Fripp, A. S. Gunn, J. G. Mackinnon, E. B. Martin, J. Pullar, C. S. G. Rogers, G. E. Smith, H. B. Titus, G. C. Torrens; Junior, F. L. Black; Students, T. H. Ayer, F. G. Brown, N. B. Eagles, J. W. P. Fogarty.
North Tryon, P.E.I. (Br. Non-Res.), Student, C. I. Bacon.
Petitcodiac (Br. Non-Res.), Student, H. G. Hughson.
Sackville (Br. Res.), Members, H. W. McKiel, F. L. West; Junior, C. F. Johns.
St. Peter's Bay, P.E.I. (Br. Non-Res.), Student, J. G. Sutherland.
Vernon, P.E.I. (Br. Non-Res.), Student, R. L. Murray.
West Bathurst (Br. Non-Res.), Student, R. R. Willis.

Saint John Branch District

(*The Counties of Saint John, Charlotte, Kings, Queens, Sudbury, York, Carleton, Victoria, Madawaska.*)

Apohaqui (Br. Non-Res.), Student, S. H. Harding.
Arthurette (Br. Non-Res.), Student, R. E. Tweeddale.
Bayswater (Br. Non-Res.), Student, J. F. Gibbons.
Bloomfield Station (Br. Non-Res.), Student, R. A. H. Hayes.
Coles Island (Br. Non-Res.), Student, T. H. Fletcher.
Edmundston (Br. Non-Res.), Member, F. O. White; Associate Members, J. E. Cade, E. W. G. Chapman, W. A. Ketchen, J. F. Mackenzie, H. A. Thompson.
Fredericton (Br. Non-Res.), Members, A. F. Baird, M. W. Black, D. W. Burpee, J. Stephens; Associate Members, A. R. Babbitt, A. A. Colter, C. G. Grant, G. M. MacPhail, A. C. Tabor, E. O. Turner; Juniors, B. H. Hagerman, J. F. Lynch, W. E. Seely; Students, W. M. Benson, D. J. Brewer, R. F. Davenport, H. N. Goodspeed, D. D. Gorman, R. W. Gough, J. R. C. Macredie, W. E. Smith, J. M. Thomas.
Grand Falls (Br. Non-Res.), Student, L. W. Bailey.
Hillsborough (Br. Non-Res.), Junior, F. G. Thompson.
Jeffry (Br. Non-Res.), Student, F. E. Crowe.
Lower Millstream (Br. Non-Res.), Student, R. J. Parlee.
McAdam (Br. Non-Res.), Associate Member, W. J. Pickrell; Student, D. S. Mills.
Minto (Br. Non-Res.), Associate Member, S. W. Babbitt; Student, N. W. Brittain.
Nashwaak (Br. Non-Res.), Student, R. W. Manzer.
Newcastle Creek (Br. Non-Res.), Associate Member, H. I. Mulligan; Student, W. L. Dickson.
North Devon (Br. Non-Res.), Students, E. R. Brannen, D. E. Coombes, J. M. MacPherson.
Norton (Br. Non-Res.), Student, J. H. Huggard.
Rothesay (Br. Res.), Students, P. M. Blanchet, J. H. Peters.
St. George (Br. Non-Res.), Student, E. L. Toy.
Saint John (Br. Res.), Members, M. Burpee, A. R. Crookshank, J. E. Freeman, A. Gray, G. G. Hare, C. C. Kirby, T. C. Macnabb, G. G. Murdoch, G. Stead, F. P. Vaughan, S. R. Weston; Associate Members, W. H. Blake, V. S. Chesnut, D. A. Duffy, J. N. Flood, J. D. Garey, G. N. Hatfield, S. Hogg, W. J. Johnston, J. H. McKinney, C. S. MacLean, T. Moffat, J. P. Mooney, H. F. Morrisey, E. J. Owens, G. H. Thurber, A. A. Turnbull, J. T. Turnbull, G. A. Vandervoort; Juniors, F. A. Patriquen, D. O. Turnbull; Students, C. A. Barbour, C. G. Clark, A. D. Davis, G. M. Donohoe, G. Y. Dow, C. M. Hare, H. P. Lingley, W. P. London, G. A. Mackie, W. E. Petersen, D. Ross, C. L. Stevenson, L. R. Stratton, W. D. Stratton, C. A. Wakeham, E. S. Watters, D. R. Webb; Affiliate, G. C. McAvity.
Sussex (Br. Non-Res.), Member, E. G. Evans; Students, H. G. M. Colpitts, A. R. Bonnell.
Westfield (Br. Non-Res.), Affiliate, J. R. White.
West Saint John (Br. Res.), Associate Member, D. G. Ross; Students, D. C. Campbell, L. G Lilley, G. G. Miller.
Woodstock (Br. Non-Res.), Associate Member E. B. Allan

Halifax Branch District

(*The Counties of Halifax, Lunenburg, Queens, Shelbourne, Yarmouth, Digby, Annapolis, Kings, Hants, Colchester, Cumberland, Pictou.*)

Amherst (Br. Non-Res.), Member, D. W. Robb; Associate Members, S. W. Crowell, H. F. Donkin, J. F. F. Mackenzie, G. T. Medforth.
Bedford (Br. Res.), Member, H. W. L. Doane.
Berwick (Br. Non-Res.), Students, W. G. Cooke, H. R. Frizzle.
Big Island (Br. Non-Res.), Student, H. C. McGee.
Bridgewater (Br. Non-Res.), Associate Member, F. G. McPherson.
Brooklyn (Br. Non-Res.), Student, J. D. Dexter.
Cariboo Gold Mines (Br. Non-Res.), Associate Member, J. Wightman.
Charleston (Br. Non-Res.), Associate Member, H. A. Morey.
Clarke's Harbour (Br. Non-Res.), Student, C. L. Kenney.
Clyde River (Br. Non-Res.), Associate Member, J. K. McKay.
Dartmouth (Br. Res.) Members, J. L. Allan, J. S. Misener; Associate Members, G. W. Christie, C. S. Creighton, R. L. Dunsmore, J. D. Fraser, W. Rodger, C. Scrymgeour; Juniors, G. L. Colpitts, E. K. Lewis, A. F. Pamenter, F. L. Thompson; Students, K. E. Bentley, R. G. Shatford, R. Thorn, A. G. Tibbitts.
Fairview (Br. Non-Res.), Student, H. A. Ripley.
Falmouth (Br. Non-Res.), Associate Member, C. W. McCarthy.
Halifax (Br. Res.), Members, S. Ball, F. A. Bowman, J. G. W. Campbell, W. P. Copp, K. L. Dawson, F. W. W. Doane, F. R. Faulkner, C. A. D. Fowler, P. A. Freeman, H. S. Johnston, H. F. Laurence, A. Macgillivray, W. P. Morrison, L. H. Robinson, A. F. Stewart, J. H. Winfield, W. A. Winfield, C. H. Wright; Associate Members, C. A. Anderson, E. L. Baillie, R. M. Barteaux, J. E. Belliveau, C. S. Bennett, W. P. Bickle, W. M. Bristol, G. H. Burchill, N. L. Cooke, C. M. Crooks, L. Cunningham, A. C. M. Davy, W. J. DeWolfe, G. V. Douglas, J. B. P. Dunbar, M. Dwyer, A. F. Dyer, L. B. Feetham, H. Fellows, S. L. Fultz, S. W. Gray, A. W. Gregory, J. B. Hayes, F. R. Henshaw, J. R. Kaye, W. S. Lawrence, P. A. Lovett, D. H. McDonald, W. G. Macdonald, J. A. MacKay, R. M. McKinnon, C. A. MacNearney, H. W. Mahon, R. R. Murray, A. D. Nickerson, R. L. Nixon, W. H. Noonan, T. W. W. Parker, G. C. Reid, J. J. Sears, A. G. Tapley, H. R. Theakston, C. St. J. Wilson; Juniors, A. D. Foulis, A. C. Harris, W. G. Muir, C. P. Roper; Students, G. F. Bennett, P. Colgan, P. B. Corkum, G. J. Currie, E. G. Dyer, J. H. Dyer, F. X. Granville, M. Harrigan, A. R. Harrington, P. C. Hamilton, F. E. Hawker, W. M. Hunt, H. J. Keating, J. F. Knodell, A. G. Mahon, J. S. Matheson, C. W. Powell, K. S. Ritchie, D. G. Tapley, G. Walsh, W. A. K. Wickwire, A. L. Wood, W. D. Woods, B. H. Zwicker; Affiliate, M. H. McManus.
Kentville (Br. Non-Res.), Associate Member, F. C. Wightman.
La Have (Br. Non-Res.), Student, G. V. Reinhardt.
Liverpool (Br. Non-Res.), Member, C. H. L. Jones; Associate Members, J. H. M. Jones, R. L. Seaborne; Junior, L. D. Wickwire.
Lunenburg (Br. Non-Res.), Student, O. B. Berringer.
Mahone Bay (Br. Non-Res.), Associate Member, F. E. Saltman.
Malagash (Br. Non-Res.), Student, R. A. Lombard.
Middleton (Br. Non-Res.), Junior, J. L. Wickwire.
New Glasgow (Br. Non-Res.), Members, A. R. Chambers, G. D. Macdougall, J. Portas, R. B. Stewart; Associate Member, J. W. MacLeod; Students, G. M. Mackie, A. H. McKinnon.
Oxford (Br. Non-Res.), Associate Member, R. D. Thexton; Student, G. V. Ross.
Pictou (Br. Non-Res.), Students, J. R. Carson, J. B. Ferguson.
River Hebert (Br. Non-Res.), Student, R. R. Smith.
St. Croix (Br. Non-Res.), Student, G. D. Spence.
Stellarton (Br. Non-Res.), Member, D. H. McDougall; Junior, H. C. M. Gordon; Student, D. C. V. Duff.
Tiverton (Br. Non-Res.), Student, H. W. Outhouse.
Truro (Br. Non-Res.), Member, W. G. Yorston; Associate Member, E. A. Crawley; Junior, W. E. Weatherbie.
Upper Vaughan (Br. Non-Res.), Associate Member, K. E. Whitman.
Wallace (Br. Non-Res.), Member, I. P. MacNab.
Walton (Br. Non-Res.), Student, E. C. Parsons.
Westville (Br. Non-Res.), Associate Member, C. D. Sampson; Student, W. C. Sutherland.
Weymouth (Br. Non-Res.), Student, C. R. Hamilton.
Wilmot (Br. Non-Res.), Associate Member, C. L. Foss.
Windsor (Br. Non-Res.), Member, H. C. Burchell; Associate Member, W. E. Hall; Students, T. B. Akin, H. N. Curry.
Wolfville (Br. Non-Res.), Members, H. W. Harkness, G. S. Stairs; Associate Member, A. Sutherland; Student, R. R. Prescott.
Yarmouth (Br. Non-Res.), Member, E. H. Morley.

Cape Breton Branch District

(*The Counties of Guysborough, Antigonish, Richmond, Inverness, Victoria, Cape Breton; and Newfoundland.*)

Angle Brook, Nfld. (Br. Non-Res.), Student, O. L. Smith.
Antigonish (Br. Non-Res.), Associate Member, W. R. Chisholm; Junior, G. T. Clarke; Student, C. S. Williams.
Black Avon (Br. Non-Res.), Associate Member, A. J. Macdonald.
Buchans, Nfld. (Br. Non-Res.), Junior, J. C. Mews.
Cape North (Br. Non-Res.), Associate Member, W. L. Ball.
Corner Brook, Nfld. (Br. Non-Res.), Associate Members, A. H. Chisholm, K. O. Elderkin; Juniors, C. Brain, G. H. Carson.
Deer Lake, Nfld. (Br. Non-Res.), Junior, E. Hinton.
Glace Bay (Br. Res.), Member, A. L. Hay; Associate Member, J. R. Morrison; Junior, J. A. Russell.
Goldenville (Br. Non-Res.), Student, D. B. Sutherland.
Grand Falls, Nfld. (Br. Non-Res.), Member, F. M. Pratt; Associate Member, H. S. Windeler; Junior, D. G. Elliot.
Guysboro (Br. Non-Res.), Students, V. A. Jost, B. N. Jost.
Mulgrave (Br. Non-Res.), Junior, D. A. Chisholm.
New Waterford (Br. Non-Res.), Student, A. M. Miller.
St. John's, Nfld. (Br. Non-Res.), Members, J. W. Morris, A. Vatcher; Associate Members, F. W. Angel, J. B. Baird, C. J. Carey; Juniors, G. A. Frecker, S. J. Hayes; Students, J. B. Angel, E. V. Burke, E. W. Cheeseman, C. J. Godden, W. C. H. Halley, J. J. Moakler, S. R. Morris, C. W. Parsons.
Sydney (Br. Res.), Members, M. W. Booth, W. E. Clarke, F. W. Gray, K. H. Marsh, T. L. McCall, S. C. Mifflen, W. C. Risley, C. M. Smyth, A. P. Theuerkauf; Associate Members, C. M. Anson, W. E. Bown, J. W. Buckley, M. F. Cossitt, W. F. Dechman, H. S. Dunn, J. A. MacLeod, R. R. Moffatt, S. G. Naish, F. G. O'Brien, W. S. Wilson; Juniors, R. F. McAlpine, J. A. Russell; Students, G. C. Hault, W. A. MacDonald; Affiliate, M. R. Chappell.
Sydney Mines (Br. Res.), Associate Member, Y. C. Barrington.
Wabana, Nfld. (Br. Non-Res.), Associate Members, C. B. Archibald, J. B. Petrie; Student, F. Rees.

Great Britain and Ireland

England and Wales

Beckenham, Associate Member, D. Kennedy.
Blackburn, Member, W. H. Hunt.
Bristol, Associate Member, F. H. Palmer.
Caernarvon, Associate Member, J. Griffith.
Chatham, Student, J. K. Flexman.
Chelmsford, Student, A. Sandilands.
Chester, Associate Member, A. Holland.
Digby, Student, A. C. Brown.
Durrington, Associate Member, F. M. Mooney.
Exeter, Member, F. J. Bellamy.
Fernhurst, Student, O. Middleton.
Fleetwood, Associate Member, G. H. Brunner.
Freshford, Associate Member, C. S. Millard.
Gillingham, Junior, R. J. Cobbold.
Grantham, Associate Member, C. A. Doherty.
High Wycombe, Member, J. R. Cosgrove.
Hyde, Junior, W. E. Adlington.
Isle of Sheppey, Associate Member, H. J. Heygate.
Leamington Spa, Associate Member, B. Starley.
Leicester, Student, A. H. Walker.
Lincoln, Associate Member, H. P. Heywood.
London, Honorary Members, His Royal Highness The Prince of Wales, K.G., His Royal Highness The Duke of Connaught, His Grace The Duke of Devonshire, K.G., G.C.M.G., The Right Hon. The Earl of Bessborough, P.C., G.C.M.G., Members, G. E. Bell, R. T. Bell, A. Brooks, W. Calder, R. E. Cleaton, N. P. Dalziel, C. G. DuCane, H. B. Fergusson, Sir Alexander Gibb, E. H. Harrison, Sir Henry Japp, C. B. Kingston, A. C. Macdonald, J. J. Macdonald, R. E. Palmer, M. A. Ravenor, A. J. T. Taylor, D. Weatherbe; Associate Members, J. K. Brooks, S. C. Carver, H. W. Furlong, H. M. Gibb, E. C. Hague, J. W. Houghton, H. C. Lott, D. S. McPhail, H. M. Mathews, O. Milne, J. B. Newton, R. F. Palmer, P. Simpson; Junior, R. L. Franklin; Students, H. R. Carefoot, C. E. Hedley, J. E. Jackson, M. P. Jolley, P. P. Muller, F. S. Stratton.
Manchester, Member, H. V. Haight.
Northwood, Associate Member, D. L. Carr.
Princes Risborough, Member, C. J. Chaplin.
Ross-on-Wye, Member, R. N. Blackburn.
Rustington, Member, A. L. Mieville.

Salterton, Member, H. A. Elgee.
Stapleford, Member, E. A. Earl.
Surbiton, Junior, C. W. Crossland.
Torpoint, Associate Member, G. O. Nancarrow.
Upton, Member, S. W. Perrott.
Wembley, Associate Member, J. A. Wilson.
Woking, Member, W. G. Tyrrell.

Scotland

Aberdeen, Honorary Member, The Right Hon. The Earl of Aberdeen.
Carnoustie, Associate Member, C. Anderson.
Cumnock, Member, J. M. Begg.
Dundee, Associate Member, G. H. Pittaway.
Dunscore, Associate Member, W. T. Wilson.
Edinburgh, Member, T. R. Henderson; Associate Member, J. R. S. Sutherland.
Glasgow, Member, J. McGregor; Associate Member, J. Shannon.
Kilmarnock, Associate Member, R. M. Herbison.
Lockerbie, Associate Member, W. M. B. Macdonald.
Midlothian, Associate Member, G. Romanes.
Selkirk, Associate Member, F. S. Gumley.

Ireland

Bray Head, Associate Member, N. F. Harrison.

Other Countries

Argentina

Basavilbaso, Associate Member, G. W. Coward.

Australia

Brisbane, Member, LeR. Wilson.
Melbourne, Member, T. P. Strickland.
Sydney, Associate Member, M. E. Tregarthen.

Barbadoes

St. Michael. Associate Member, J. F. Layne.

Belgium

Linkebeek, Member, R. H. Parsons.

Bermuda

Ireland Island. Student, B. C. Sibley.
Tuckerstown, Member, F. G. Rounthwaite.

Brazil

Rio de Janeiro, Associate Members, L. H. Armstrong, C. J. Oliver.

British East Africa

Nairobi, Member, Brig.-Gen. Sir G. D. Rhodes.

British Guiana

Georgetown, Member, J. C. Craig; Junior, H. S. Wright.
McKenzie, Associate Member, C. P. Howrigan.

British Honduras

Belize, Member, H. C. Carter.

China

Canton, Student, G. J. Jue.
Tientsin, Member, H. F. Barnes.

Colombia

Bermeja, Associate Member, F. C. Tempest; Junior, J. S. Kyle.

Czechoslovakia

Harmanec, Associate Member, T. W. Toovey.

Denmark

Espergaerde, Associate Member, J. Nicolaisen.

Finland

Helsingfors, Student, B. Heimburger.

France

Paris, Student, G. Bertrand.
St-Laurent Blangy, Associate Member, D. C. Unwin Simson.

Germany

Freiburg, Associate Member, W. A. Miescher.

India

Dehra Dun, Member, L. N. Seaman.
Delhi, Honorary Member, His Excellency The Right Hon. The Earl of Willingdon, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E.
Dharmsala, Associate Member, L. S. Adlard.
Peshawar, Associate Member, W. M. Miller.

Iraq

Baghdad, Member, C. B. R. Macdonald.

Jamaica

Ewarton, Student, O. M. Clarke.
Kingston, Student, H. T. Hart.
Montego, Associate Member, A. M. Alberga.

Malta

Valletta, Associate Member, A. F. Galea.

Mexico

Mexico City, Members, G. R. G. Conway, F. S. Easton; Student, A. M. Johansen.
Tampico, Member, Capt. W. A. Ervine-Grim.

Newfoundland

Angle Brook, Student, O. L. Smith.
Buchans, Junior, J. C. Mews.
Corner Brook, Associate Members, A. H. Chisholm, K. O. Elderkin; Juniors, C. Brain, G. H. Carson.
Deer Lake, Junior, E. Hinton.
Grand Falls, Member, F. M. Pratt; Associate Member, H. S. Windeler; Junior, D. G. Elliot.
St. John's, Members, J. W. Morris, A. Vatcher; Associate Members, F. W. Angel, J. B. Baird, C. J. Carey; Junior. G. A. Frecker; Students, J. B. Angel. E. B. Burke, E. W. Cheeseman, C. J. Godden, W. C. H. Halley, J. J. Moakler, S. R. Morris, C. W. Parsons.
Wabana, Associate Members, C. B. Archibald, J. B. Petrie; Student, F. Rees.

Norway

Oslo, Associate Member, O. S. Platou.

Palestine

Jerusalem, Associate Member. J. F. Rowland.

Panama

Colon, Associate Member, G. R. Adams.

Persian Gulf

Abadan, Member, Lt.-Col. E. V. Collier.

Peru

Talara, Associate Members, G. E. Kent, B. P. Ripley; Students, R. V. Anderson, L. E. Mitchell.

Philippine Islands

Cebu, Associate Member, G. R. Ewart.

South Africa

Johannesburg, Associate Members, R. J. Fisher, O. J. Rorvik, C. V. von Abo.

Spain

Barcelona, Associate Member, C. P. Mills.

Switzerland

Baden, Associate Member, H. C. Beck.
Winterthur, Junior, M. Du Bois.

Tasmania

Launceston, Associate Member, A. Fraser.

Trinidad

St. Joseph, Associate Members, L. R. Gransaull, P. R. Gransaull.

Turkey

Angora, Member, J. N. Aggiman.

Venezuela

Maracaibo, Member, R. W. Tassie; Junior, M. G. Taylor.

United States of America

Alameda, Cal., Associate Member, G. B. Ashcroft.
Amherst, Mass., Associate Member, C. A. Leighton.
Ampere, N. J., Member, F. F. Longley.
Ann Arbor, Mich., Member, H. E. Riggs.
Astoria, N.Y., Associate Member, C. M. Barnes.
Azusa, Cal., Member, B. E. Barnhill.
Baltimore, Md., Associate Member, J. A. Walls.
Bayonne, N.J., Associate Member, E. M. Benedict.
Berkeley, Cal., Member, V. L. Havens; Associate Member, E. E. Weibel.
Berlin, N.H., Member, M. Jacobs.
Black River, N. Y., Junior, W. V. Delancy
Bloomfield, N.J., Member, M. H. Teaze.
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Modern Sewage Treatment

With Particular Reference to Conditions in the City of Winnipeg

W. D. Hurst, A.M.E.I.C.,

Assistant Engineer, in charge of Waterworks, City of Winnipeg, Man., and Secretary, Board of Engineers, Greater Winnipeg Sanitary District.

Paper presented before the Winnipeg Branch of The Engineering Institute of Canada, April 18th, 1935.

SUMMARY.—The sewage problem in the city of Winnipeg is now being dealt with, and the author, after outlining the existing conditions and the possible means of treatment, describes the progress made to date on the construction of the new secondary sewers, interceptor and pumping and treatment plant.

In 1932 Mr. S. W. Lea, M.E.I.C., consulting engineer, of Montreal, reported to the city of Winnipeg on the problem of sewage disposal, and the need of a proper system of disposal is covered in his first report, hence its desirability will not be discussed here. In this paper Greater Winnipeg refers to the cities of Winnipeg and St. Boniface, the towns of Tuxedo and Transcona, and the rural municipalities of East and West Kildonan, Fort Garry, St. Vital and St. James. Greater Winnipeg has a population of roughly two hundred and seventy-five thousand inhabitants, and the sewage from this population is discharged without treatment by forty-nine public outlets into the Assiniboine and Red rivers. In addition to this there are a dozen private industrial outlets.

Sewage

Sewage usually consists of the spent water supply of a community containing solids of animal and vegetable origin from the kitchens and bathrooms, and in some systems surface water from the streets, as well as wastes from industrial and commercial establishments. The wastes from industrial establishments are usually considerably stronger than domestic sewage, and are more difficult to handle at the treatment plant.

There are two general systems in use for the handling of wastes—

(1) The dry carriage system.
(2) The water carriage system.

The dry carriage system has largely disappeared on this continent except in isolated dwellings and villages.

The water carriage system is sanitary, and removes household wastes quickly and economically to the point of disposal.

Reasons for Treatment.

One reason why sewage is treated is because it may and usually does contain the germs of serious intestinal diseases such as typhoid fever, dysentery, both amoebic and bacillery, cholera, etc. In one million pounds of sewage (100,000 gallons) there is contained 800 pounds of solids (dry weight) 400 pounds of which is organic matter, and it is this 400 pounds of organic matter that gives rise to the main problem of sewage disposal.

This organic matter is eventually broken down by bacteria and micro-organisms into inert matter. When the decomposition takes place in contact with oxygen, nuisance is not caused, but in the absence of oxygen putrefaction is set up.

The discharge of sewage into a body of water may be objectionable for two main reasons:—

It may constitute a menace to health through bathing, and through the use of ice and by drinking water from the polluted waters. It can also result in the destruction of fish life.

It may constitute a nuisance for aesthetic reasons, due to the decomposition of the sewage, resulting in foul odours and discoloration of the waters, as well as the unsightly appearance of sewage solids floating on the surface.

The solids referred to above may be classified as follows:

(1) *Floating solids.* These solids are apt to be strewn on the shores, or be entangled in aquatic plants near shore, and form a decomposing slime objectionable to sight and smell.

(2) *Settling solids.* If the velocity of the receiving stream is low enough the heavier organic solids will settle and form sludge banks which decompose, forming gas which carries the rotting sludge to the surface, the process repeating itself over and over.

(3) *Solids in solution.* The solids referred to above represent less than one-half of the organic matter. The remainder is in solution, and it can neither be screened nor settled out of the sewage, and because of its finely divided state has proceeded further toward decomposition than the floating or settling solids, and is a heavy consumer of the oxygen held in solution in the receiving body of water.

Oxygen Content of Water.

The whole problem then resolves itself as follows: If there is sufficient oxygen in solution in the receiving body of water, or if it can be replenished fast enough by atmospheric reaeration, no nuisance will result. The nuisance incidence is determined by four factors:—

Volume and character of the sewage discharged.

Volume and character of the water available for dilution.

The velocity of the receiving body.

The temperature of the receiving body of water.

Now to consider these factors as they apply to the local situation.

There are discharged from the sewers of Greater Winnipeg each day roughly eighteen million gallons of sewage into the Red and Assiniboine rivers. The sewage from several of the outlets is in a septic condition when it is empt'ed into the rivers, and contains large quantities of industrial wastes.

There has already been much said of the decreasing flow of these rivers, and any determination as to whether the river or receiving body is capable of handling the sewage delivered is a complicated problem, but an approximate way of getting at this important factor is by the so-called dilution ratio. This is expressed in terms of c.f.s. per one thousand of the contributing population. Modern practice states that if the flow of a stream is less than 3.5 c.f.s. per one thousand persons discharging into it, a nuisance more or less widespread is the rule rather than the exception.

Dilution Ratios c.f.s. per 1,000 Population for Various Months from 1913 to Date for the Red River at Louise Bridge

	Jan.	Feb.	Aug.	Sept.	Oct.	Dec.
1913	4.8	3.4	24.0	16.4	12.4	5.4
1914	4.6	4.4	9.8	8.9	9.7	4.6
1915	4.5	4.3	17.2	10.7	11.0	7.8
1916	5.0	4.5	33.5	25.8	20.7	10.0
1917	7.2	6.1	9.2	5.8	6.5	4.2
1918	1.6	1.6	7.2	6.7	4.4	3.9
1919	3.4	3.0	23.7	11.2	9.0	4.0
1920	4.6	4.9	11.9	8.3	8.5	6.1
1921	4.4	4.1	8.9	9.9	13.0	7.8
1922	4.5	3.0	10.2	7.8	6.7	4.2
1923	3.2	3.1	19.4	10.5	8.9	6.3
1924	2.8	2.7	7.0	5.7	7.9	3.2
1925	1.9	1.9	7.6	5.9	7.8	5.0
1926	3.2	3.3	4.6	5.4	8.7	4.5
1927	3.5	3.1	19.8	15.6	16.2	6.3
1928	4.9	4.6	20.2	18.0	13.4	6.3
1929	5.4	4.8	3.6	2.7	3.4	2.5
1930	1.8	1.5	3.5	2.4	2.5	1.8
1931	1.6	1.6	1.7	1.6	1.9	4.9
1932	1.1	0.9	1.6	1.5	1.9	1.0
1933	0.8	0.7	2.0	1.3	1.2	1.1
1934	1.0	1.0	1.0	0.8	1.2	0.7
1935	0.4	0.6	...	...	...	...

This table shows that during the months of August, September and October, from 1913 to date, the dilution afforded by the rivers has for sixteen months been less than that required to prevent nuisance. Curiously enough these sixteen months are all after 1928. They also show that during the months of December, January and February from 1913 to date, the dilution afforded by the rivers has for thirty-one months been less than that required to prevent nuisance. Sixteen of these thirty-one months are after 1928.

The following criteria have been established regarding the character of the water available for dilution.

If the free ammon'a exceeds one-half part per million, the receiving body is likely to cause nuisance. Similarly if the dissolved oxygen falls below 50 per cent of the saturation value, nuisance can also be expected.

The British Royal Commission on Sewage Disposal stated that if the stream water could take more than 4 p.p.m., dissolved oxygen nuisance would likely be caused. In this country this is referred to as bio-chemical demand, abbreviated b.o.d.

In 1931 Mr. Archibald Blackie, city chemist, made determinations of these and other factors affecting the situation and the McCrady Memorandum tabulated them. These results have been prepared in graph form in order that they may be visualized more easily.

The third important consideration is the velocity of the receiving body of water. Velocities of the order of 0.15 foot per second will reduce by sedimentation 50 per cent of the suspended solids of average sewage in twelve hours. During the period July-September 1931, the velocity of the Assiniboine river averaged 0.25 f.p.s. while the Red averaged but 0.07 f.p.s. It took thirty-three hours to transport the sewage from Aubrey street to the junction of the Assiniboine and Red and one hundred hours additional to carry it to St. Johns Park. Two hundred and ninety-five hours were required to transport sewage from the civic hospitals

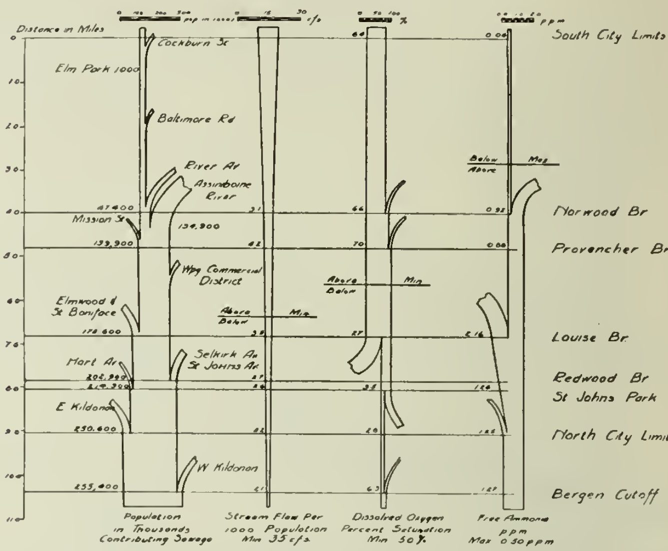

Fig. 1—Population Contributing Sewage and Extent of Pollution of Red River.

to St. Johns Park. Hence one can fully expect to have somewhere in the vicinity of 50 per cent of the suspended solids in the sewage deposited on the river bottoms before it gets out of Winnipeg.

The temperature of the receiving body of water governs the speed of the biological action of bacteria and other organisms on the organic matter contained in the sewage. It is also a fact that water is capable at low temperature of holding more oxygen in solution than at high temperatures, and hence nuisance is not so readily set up if the water is cold. However as the water freezes, the ice cover prevents the water from taking up oxygen from the air, and hence putrefaction starts again when the oxygen is exhausted.

Dr. McCrady has summed up the local situation very well. He states in his memorandum:

"The condition of the rivers may be described as follows:—

Gross pollution, during the late summer, prolonged in duration until the latter part of the month of October.

Reduced pollution, during the period of change from summer to winter conditions, by reason of autumn rains and falling temperatures. This stage was completed about the first week in December.

Increasing pollution under winter conditions of resumption of restricted stream flow, and prevention of reaeration by the ice cover."

General Means of Treatment.

There are two general methods of treatment where outlets are scattered along many miles of river bank:

(1) Individual treatment plants at trunk sewer outlets.

(2) One or more large treatment plants with intercepting sewers leading to them.

(3) A combination of these methods.

Mr. Lea reported on this subject in September 1934, and recommended the interceptor and single treatment plant.

The city then is faced with the design of a proper interceptor. Here, too, there is the choice of three general types:

(1) Gravity interceptor.

(2) Pressure interceptor with pumping stations at each outlet.

(3) A combination of both types.

The engineers are considering what scheme will be the most economical to build and operate as well as be the most practical.

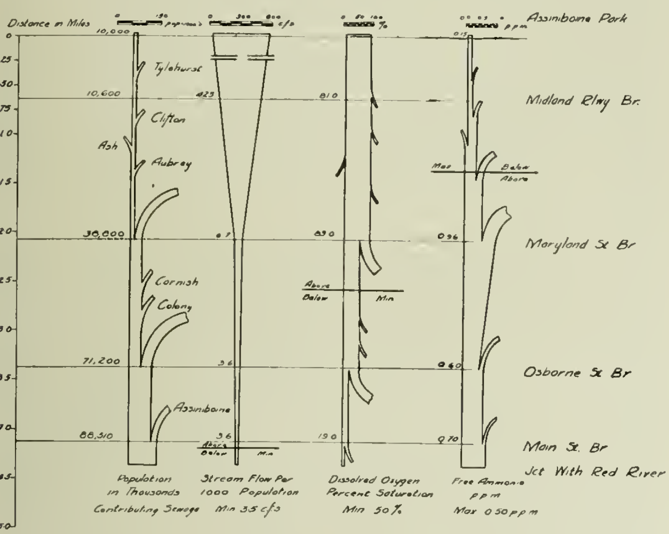

Fig. 2—Population Contributing Sewage and Extent of Pollution of Assiniboine River.

The interceptor according to the present proposal starts near Aubrey street, picks up Ash street sewer discharge by inverted syphon, follows east on Wolseley avenue to Furby street, picks up Cornish sewer discharge, runs up Furby street to Broadway, runs east on Broadway, picks up Colony street sewer discharge, at Main street picks up sewer discharges from Assiniboine avenue, River avenue, Jessie avenue and Marion street sewers.

The route then follows Main street to beyond the north city limits of Winnipeg picking up the discharge from the following sewers:

Bannatyne, Robert, Mission, Orleans, Boyle, Syndicate, Selkirk, St. John's, Hart avenue and Polson avenue. The secondaries from Mission, Orleans and Hart avenue sewers cross the river by inverted syphons.

The depth of the interceptor at Aubrey street is twenty feet from surface of ground to invert, and at the plant forty-eight feet. At this depth provision has been made for the extension of the sewer westward into St. James municipality of such a size as to amply take care of the increase in population. At Aubrey street the interceptor is four feet diameter, it increases in diameter to seven and a half feet at the treatment plant.

It is not proposed to extend this system further south than Jessie avenue.

PART II

Sewage treatment is in reality a problem in classification. The following solids are found in sewage:

Class I Rags, skins, wood, paper, hair.
This class can be incinerated or disposed of without nuisance or odour.

Class II Coal, sand, grit and other inert matter.
These cause no odour troubles.

Class III Organic solids, consisting of fecal matter, kitchen wastes both of animal and vegetable origin, and usually of small size.
This matter is apt to cause nuisance, and cannot be detained long in the vicinity of human habitation.

Sewage practice may vary in detail of application, but the basic principles are the same, and are universally accepted. Purification of sewage can be correctly regarded as artificial adaptation of natural processes. Modern treatment has been so thoroughly developed that if the treatment units are properly selected, and the sequence is proper any desired degree of treatment may be obtained.

This all sounds very simple, but such is not the case. The degree of refinement to which the process should be carried is a matter of great importance. This usually depends on the following things among others:

Danger to health of persons using the receiving body.

The value of the stream for ice harvesting, oyster beds, fisheries.

The water supplies taken from the stream below the point of discharge.

The sites available for treatment plants.

The type of sewage and its condition.

The Provincial or State Board of Health usually decides after thorough study of the problem what strength of effluent they will permit to be discharged into the receiving body.

To obtain a plant that will be economical in first cost and in operation, free from operating troubles, and will produce a thoroughly satisfactory effluent requires the judgment of the specialist in sewage treatment. This branch of sanitary science is changing so rapidly from day to day that the average engineer cannot hope to keep abreast

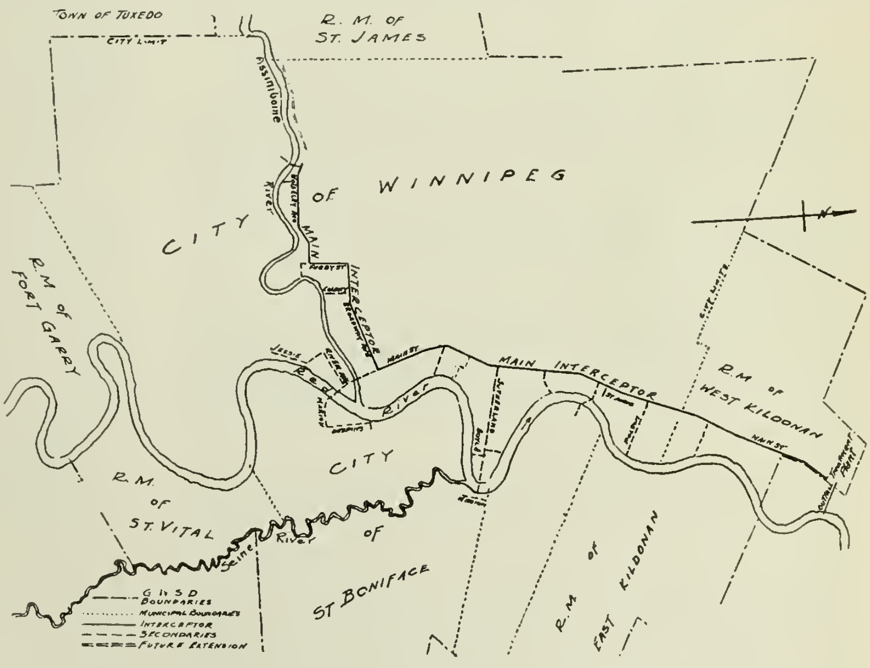

Fig. 3—Proposed Sewerage System for Greater Winnipeg Sanitary District.

of the changes in the biological, chemical, bacterial and mechanical factors.

PRIMARY TREATMENT

The first piece of mechanism usually encountered in a sewage treatment plant is the coarse bar screen. This consists of bars usually placed from ½ inch to 2 inches apart, and is simply a barrier placed in the flow of the sewage to intercept large solids. These racks may be fixed or movable, and either cleaned by hand or mechanically. The material taken from these screens may be burned or hauled away. The screenings usually amount to from 1 to 6 cubic feet per million gallons.

Grit Removal.

The next problem in classification is the removal of sand, grit, and other inert solids. If the velocity of flow is reduced sufficiently, these solids will settle out. The velocity usually adopted is one foot per second. This will allow the grit to settle, but is not low enough to cause the organic matter to settle out. It is only necessary, therefore, to widen out the sewer into tank form. The length of the chambers is governed by the amount of grit to be stored, but is usually fixed by making the detention period one minute.

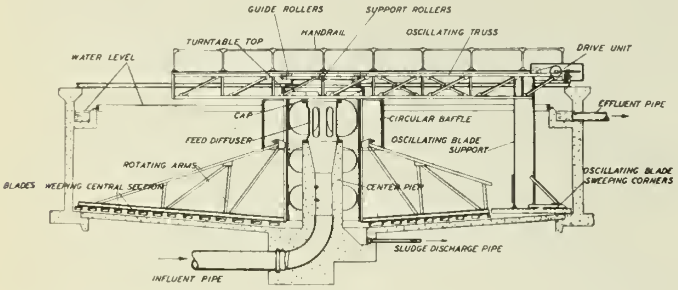

Fig. 4a—Dorr Siphon Feed and Traction Drive Clarifier.*

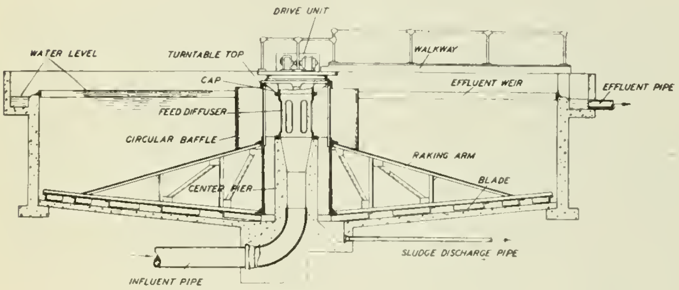

Fig. 4b—Dorr Siphon Feed and Central Drive Clarifier.*

Grease Catchers.

With the advent of the motor car more oil and grease have been discharged into municipal sewers. The oil and grease have a bad effect on treatment processes, and therefore should be removed. Tanks with skimming mechanism and provided with air agitation are now widely used, and solve the problem very well.

Detritors.

The Dorr detritor is an ingenious mechanically cleaned grit chamber. The movement of the grit is outward, and ploughs mounted on four revolving radial arms carry the grit to the inclined channel along one side of the chamber. Here it is picked up by a reciprocator which washes the grit, and at the same time it is pushed up an incline and out of the tank. While passing up the incline any organic solids are separated from the grit and carried back to the basin through a special opening. It is claimed that the discharged grit contains less than 5 per cent of organic matter, in which state it remains free from odour and can be used for filling without risk of offence.

Clarification.

The next step in the process of classification is the removal of the settleable organic solids in the sewage. These are the most difficult to remove due to their small size and their tendency to decompose, and to cause odours. A few years ago one popular method to remove these organic solids was that of fine screening, but this method is rapidly disappearing in favour of settling tanks which are much more effective and efficient.

Fine Screening.

Fine screens consist of perforated metal plates or wire mesh with opening of 3/64 inch to 3/32 inch, and are practically all of the movable type, and are either machine cleaned or self-cleaning. One advantage of screens is the small space required for screening works, but the most important disadvantage is the character of the screenings. Objectionable odours are almost inevitable if the screenings are not buried or incinerated. Another method of getting rid of them is to mix them with ripe sludge, and allow them to digest in sludge digesting tanks.

Settling Basins.

Better than screens is a reduction of velocity causing settlement in tanks where the organic solids may be removed mechanically or by hand. The principle is the same as in the grit chamber, namely, an enlargement of the sewer into tank form where the bulk of the solids which are of a higher specific gravity than water will settle. In order to assist the very fine solids and those in solution to settle, chemicals which form a floc are sometimes added. Before this is resorted to careful study should be given to the whole problem as there may be more economical means of attaining the same end.

The settlement in the bottom of the tank is called sludge and is in a form that will decompose rapidly unless attended to and removed. The velocity of flow through these tanks usually varies from 0.15 inch per second to 2 inches per second and the detention period varies from one-half to eight hours, an hour and a half being common.

The continuous mechanical removal of the sludge is desirable from many standpoints, among them being the following: Storage space does not have to be provided for the sludge. It provides easy means of returning a portion of the fresh settled sludge to the influent.

Septic Tanks.

It was learned years ago that if the solids in sewage were allowed to undergo natural decomposition they would eventually reach a stable and inert state. The first unit to use this principle was the septic tank developed by Cameron in Exeter, England. Collection and decomposition were carried out in the same tank, sludge being removed only after long periods. Many of the important claims advanced in favour of this system have failed to stand the test with the result that it is now practically obsolete.

The septic tank still has its uses for treatment of sewage from institutions, but most boards of health will not permit its use in municipal treatment plants.

After the process had been studied Travis in England and Imhoff in Germany recognized the impracticability of carrying on two separate and distinct processes in a single storey tank. They developed tanks which provided an upper compartment in which the solids were removed by settling and a lower or digestion compartment where they were allowed to undergo digestion. These tanks, too, had their faults, foaming being the principal operating fault. The gas that is generated is either collected in gas collectors or discharged into the atmosphere, the latter method sometimes resulting in odours around the plant.

Another disadvantage of the Imhoff or Travis tanks is the heavy cost of construction due to their depth.

Separate Sludge Digestion.

The next logical step was to arrange to have the processes of sedimentation and digestion carried on in separate

*Courtesy of the Dorr Company.

tanks, the process being known as the "separate sludge digestion" process. It eliminated the disturbance of quiescent settling due to gas being given off in the lower compartment and allowed the operator to control the contents of the digestion unit. As it was shallow it was of course, cheaper to build.

When the separate sludge digestion tanks were first used they had all the faults of their predecessors, foaming, odours, and a small yield of gas mostly hydrogen sulphide. However, they were amenable to study and research, and it was soon discovered that bad conditions only existed when acid conditions were prevalent in the tanks. When reagents were added changing the contents to an alkaline condition an immediate improvement was noted. No foaming, no odours, a large quantity of gas, and a 50 per cent reduction of organic matter. This gas contained 75 per cent of methane by volume, which is odourless, and had a heat value of 650 B.t.u. per cubic foot. Well-digested sludge is black, gritty and has a tarry odour. It was found that in the cold winter months the digestion tanks became merely storage tanks and very little digestion went on. However, if the tanks were artificially heated normal conditions were resumed. This, would be expensive but for the gas yield from the digesting sludge which was more than adequate.

Temperature is a particularly important factor in alkaline fermentation. Gas production begins at 42 degrees F. and increases uniformly up to 77 degrees F. after which it falls off. In well operated digestion tanks the ratio of digested sludge to fresh sludge is usually greater than 1 to 1. It was also found that it was desirable to maintain contact between the digesting solids and the daily addition of fresh solids. For good digestion the *pH* value should run from

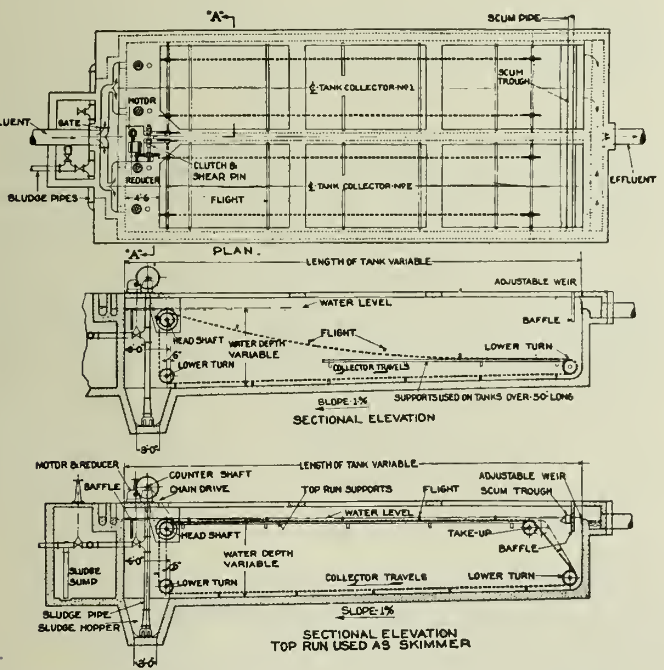

Fig. 5—Arrangement of Link-Belt Straight Line Sludge Collectors.*

7.0 to 7.6. One cubic foot per capita is usually provided in digestion tank design corresponding to an effective digestion period of two months.

A new development in digestion tank design embodies a two stage principle involving two tanks. The first tank is provided with high speed agitation, breaking down solids rapidly, the sludge then automatically passing to the second tank where quiescent conditions and gas collection are accomplished. It is claimed that 90 per cent of the total possible gas is produced in ten to twelve days. If this is a fact the tank sizes can be reduced and a larger volume of gas obtained.

Gas production varies from 0.4 to 0.8 cubic foot per capita per day and averages 650 B.t.u. Many plants in Europe use the gas for supplying power for the plant especially where the cost of electric energy is high. In most American plants the gas is used to heat the digestion tanks and to incinerate screenings and sometimes to heat the plant. Where current is cheap some plants sell the surplus gas to the local gas company.

The disadvantage of this form of digestion is the accurate and constant control required.

*Courtesy of the Link-Belt Company.

Secondary Treatment

All the solids that can be removed by purely physical means have now been removed. However, there is still left in the sewage liquid (the effluent) now leaving the clarifiers, 200 p.p.m. of dissolved organic solids that must or at least should be removed before the effluent is sent to the receiving body. For this purpose oxidation is required causing an irreversible chemical change. Air must now be naturally or mechanically supplied for the cultivation of bacteria that will convert the organic matter into stable inoffensive compounds.

Land Irrigation.

The first method used was the application of the effluent to land properly treated. The sewage was allowed to overflow on to the land in thin films, the percolated sewage being collected in shallow trenches or ditches. It was rare that land could be found that would absorb sewage without being first underdrained at considerable expense. Even then prolonged droughts caused the clayey soil to crack which allowed the sewage to short circuit to the drains without material reduction of its degree of pollution. Hence sewage farming was abandoned due to economic, administrative and sociological factors.

Land Filtration.

The next method tried was to run the sewage on to sand beds through which it percolated to underdrains. An acre of land was required to take care of 120,000 gallons a day and for large cities this was quite impractical.

Contact Beds.

The next step was the introduction of the contact bed which usually consisted of a concrete basin 5 to 6 feet deep filled with broken stone. Sewage was then applied filling it nearly to the top of the stones and allowed to remain in the basin for two or three hours and then released. A slimy biological film formed on the stones after the beds matured destroying the organic matter in the sewage. This filter was capable of treating 325,000 gallons per acre per day which made it still out of the question for large cities. The bed soon clogged up reducing its capacity with the result that the aggregate had to be removed, washed, screened and replaced, and the process is now obsolete.

Trickling Filters.

The contact bed was replaced by the trickling filter which consisted of fixed sprinkler nozzles or distributors spraying the sewage over beds consisting of stone 6 to 8 feet deep which is underdrained. This was a great improvement over the contact bed especially as 300,000 gallons per acre per day per foot depth could be treated. However, this type of treatment is still widely used and results are good, but for larger cities the land required was a stumbling block.

Activated Sludge Process.

Development in England of the activated sludge process by Ardern and Lockett has largely solved the problem of secondary treatment when area is limited. The sewage is aerated in tanks either by agitation by paddles or by forcing compressed air through it. The air serves three purposes, first providing oxygen to maintain bacterial conditions existing only in its presence, secondly to cause the sludge so activated to move through the sewage maintaining contact between the gelatinous surfaces of the sludge and the putrescible organic matter in the sewage and thirdly to prevent the sludge depos ting and becoming septic, upsetting the process. As in other biological processes two to four weeks must elapse after the tank is put in operation to produce activated sludge which is very flocculent and has a golden brown colour. Once the tank is broken in the sludge will retain its action under favourable conditions, sludge being withdrawn daily of which an amount of 20 per cent to 25 per cent of the sewage flow is returned to the influent in order that it may become activated in a short period. If the sewage is properly activated it will settle rapidly and to accomplish this secondary clarifiers are provided. One hour's detention usually suffices.

One of the chief difficulties with the activated sludge process is the immense volume of sludge produced. As activated sludge has a moisture content of from 98.5 per cent to 99.5 per cent. Another disadvantage with the process is the large volume of compressed air required and the cost thereby entailed.

However, the results are good and the suspended matter in the sewage is often reduced 90 to 95 per cent by the process and the bacteria reduced 90 per cent.

Thirty horse power are required for furnishing 1.5 cubic feet per hour per gallon of sewage for the treatment of 1,000,000 gallons per day.

Chemical Precipitation.

It has been recognized for many years that a process somewhere between sedimentation and complete treatment was desirable. As was stated previously the oxidation processes are very delicate and not flexible and often produce an effluent of greater purity than necessary and at a high cost. On the other hand sedimentation does not do enough. During the past seven years intense study has been given to this phase and there has evolved what is known as the chemical-mechanical processes. One of the best known, the Laughlin process, was operated as a pilot plant in Coney Island, N.Y. and later as a full size plant built at Dearborn, Michigan. The incoming sewage passes through screens and then flows to the mixing chamber. Here is added a mixture of grit, screenings, lime and waste paper and ferric chloride. This mixture is than delivered to a clarifier equipped with a magnetic cleaner. The effluent goes to the river while the sludge is sent to vacuum filters and then for final disposal.

The clarifiers are the most interesting part of the installation. In the Dearborn installation the tanks are 60 feet in diameter, 10 feet deep at the outside and 12 feet deep at the centre.

Around the inside circumference of the tank is a shelf-like arrangement 8 feet wide. This supports a coarse grating on which is placed a phosphor-bronze screen with 1 mm. openings.

On this screen is placed 3-inch magnetite graded between No. 10 and No. 16 screens. Sewage enters the tank at the centre through a 7-foot circular baffle wall and flows radially outward to and upward through the magnetic filter. It then passes over weirs into an effluent channel that completely surrounds the tanks. The filter is provided with a bronze cleaner case suspended from a truss as long as the filter bed is wide and itself 4 feet 6 inches in width, the top being just a few inches above the surface of the liquid. In the bottom is a longitudinal opening over which is mounted a long bronze solenoid wound about a vertical axis. The solenoid is as long as the cleaner case, about 18 inches wide, and covers a narrow sector of the filter bed. As the cleaner travels over the surface of the filter it is periodically energized by direct current and when so energized it picks up violently a narrow sector of magnetite. The uprushing liquid from beneath the screen scrubs and cleans this magnetite and then overflows into the cleaner case into a side compartment from where it is pumped back to the centre of the tank. When the solenoid is demagnetized the magnetite drops and is trowelled down by the cleaner case. The solenoid operates at 16.9 cycles per minute and the cleaner travels completely around the filter in thirty-three minutes.

The following results were obtained with this plant in 1932:

Per cent total solids removed	63
Per cent suspended solids removed	97.5
Per cent b.o.d. reduction	87

Experiments are going on at the present time and the results so far are meagre but promising. Several cities are considering chemical precipitation and hope thereby to reduce both capital and operating costs.

Sludge Disposal

Sludge disposal always has been and still is one of the most difficult problems of sewage treatment. Sludge before drying is a thick, syrupy liquid having a moisture content of from 94 to 98.5 per cent depending on the process producing it.

Primary treatment produces 2,000 gallons per million gallons of sewage and from activated sludge process 11,000 gallons per million gallons of sewage. Digestion will reduce this by 50 per cent but there still remains a great mass requiring disposal.

Wet sludge is still commonly run on to specially prepared sand beds and air dried. In order to reduce the amount of land required the sand beds are often covered with a greenhouse structure which of course raises the capital cost considerably.

Fig. 6—Dorr Multidigester System. General view of Unit at Cedarhurst, L.I., with primary tank at right and secondary tank at left.
Courtesy of The Dorr Company

At the present time probably the most successful method of dewatering sludge is by using the vacuum filter. Before reaching the filter the sludge must first be conditioned with ferric chloride or chlorinated copperas as this makes the filter rate higher and thus reduces the cost of filtration.

Milwaukee has produced a high grade fertilizer by heat drying vacuum filtered activated sludge and adding to it other chemicals, but due to the cost this has not met with favour elsewhere.

Ordinary sludge is usually put on barges and dumped at sea, is used for filling up low land or is sometimes sold to farmers as a low grade fertilizer. Filtered sludge may be incinerated if mixed with other fuel but incineration is still in the experimental stage

A reference should be made to costs as this has been the bugbear of sanitary engineers. Some plants do not include capital charges in their published costs, others do not include cost of pumping and some do not include interceptor costs and cost statements are therefore often misleading. Certain cost data have here been abstracted from a recent article by Besselievre but as he does not give operating costs these have been taken from the author's files to supplement the information. It is believed to be substantially accurate. Perhaps, too, it should be mentioned that the capital cost of the treatment plant and interceptor for Greater Winnipeg has been estimated as follows:

1. Interceptor, pumping plant, clarification plant for 200,000 connected population and land and administration and incidentals—$3,250,000.00.
2. Interceptor, pumping plant, activated sludge treatment for 200,000 connected population and land and administration and incidentals—$4,000,000.00.

In closing, the following quotation from the first report of Mr. W. S. Lea to the City of Winnipeg on sewage disposal is of interest:

"In summary it may be said that sewage treatment plants are imperative where needed as a public health measure. They are of great worth also as a cure for nuisances in rivers. On the other hand the community which has to resort to them, is often left with something of a nuisance on its hands on shore. Moreover, the capital and operating costs of sewage treatment plants entail a substantial annual expenditure from which there is no direct monetary return. It follows, therefore, that the minimum which will suffice, is the maximum which should be recommended to a community, which has to operate and pay for sewage treatment plants."

Cost of Sewage Treatment

Treatment Process	Area Req'd. per m.g.d	Per cent Removal Suspended Solids	Per cent Removal b.o.d 5 Day	Construction Costs per m.g. (U.S.)	Operating Costs per m.g. Treated (Capital charges not included)
1. Fine screening....	½ acre	16 per cent	...	$20,000	....
2. Sedimentation...	1 acre	65 "	30 per cent	30,000	$10
3. Sedimentation and chemical precipitation..............	1¼ acres	90 "	80 "	40,000	....
4. Sedimentation with trickling filters..............	6 acres	96 "	80-90 "	60,000	$6 to $12
5. Activated Sludge	2 acres	96 "	90 "	80,000	$16 to $27

Note:—After Besselievre with exception of operating costs and b.o.d. per cent removal (authors). Cost of land and incineration of screenings not included.

Supplementary Notes*

Historical

During the years 1930 and 1931, the condition of the Red and Assiniboine rivers had become exceedingly bad owing to extremely low flows and increasing sewage pollution. Accordingly in August 1931, the City Council of Winnipeg appointed a committee to enquire into the necessity or otherwise of a sewage disposal plant for the city of Winnipeg. This committee recommended that Mr. W. S. Lea, M.E.I.C., consulting engineer of Montreal, be asked to make a report on the situation. This recommendation was concurred in, and Mr. Lea made his report in February 1932. During the interval, a sanitary survey of the rivers was carried out by the City Engineer's Department. Mr. Lea recommended in his report:

(1) That the sanitary survey be continued throughout the summer of 1932.
(2) That the city of Winnipeg continue the investigations outlined in the report, requisite to the adoption of a practically complete scheme for its future sewage treatment needs.
(3) That the necessary lands be acquired for the interceptor and treatment plant.

No action was taken on this report, but Mr. Lea was retained to go further into the scheme.

Conditions grew worse during 1932 and 1933, and in September 1933, the Manitoba government called together representatives of the municipalities surrounding Winnipeg for a conference on sewage treatment.

This inter-municipal conference went on record as "approving of a scheme for the disposal of raw sewage, and of providing for Winnipeg and suburban area, a sewage disposal system."

The committee also appointed an Engineering Committee consisting of the municipal engineers, and engineering representatives of the Dominion and Provincial governments. The engineers were instructed to examine the existing data on the subject and to prepare estimates of cost. This committee together with Mr. W. S. Lea made a very complete study of the project throughout 1933 and 1934. In March 1935, a bill to create the Greater Winnipeg Sanitary District was introduced in the Provincial Legislature. The bill was passed and came into effect in June 1935. Meanwhile negotiations had been carried on with the Dominion government with a view of giving financial assistance to the project as an Unemployment Relief Measure.

In July 1935, an agreement was signed by the Dominion government and the Provincial government in which the Dominion undertook to assist the project financially.

Following this, the Administration Board of the Greater Winnipeg Sanitary District with Mayor John Queen of Winnipeg as chairman, came into being. This Board appointed a Board of Engineers consisting of the engineers of Winnipeg and the municipalities comprising the district, together with engineers representing the Dominion and Provincial governments. This Board was charged with the construction of the sewage disposal project. Mr. Lea was named consulting engineer. The personnel of this Board is as follows:

W. P. Brereton, M.E.I.C.,
Chairman and Chief Engineer
R. W. McKinnon, M.E.I.C.
J. W. Battershill
Chas. F. Gray
W. D. Hurst, A.M.E.I.C.,
Secretary.

*The following notes are not intended to constitute part of the paper but merely to indicate the progress which has been made in the construction of the greater Winnipeg intercepting sewer and sewage disposal project.

A technical staff was engaged and D. L. McLean, A.M.E.I.C., was named assistant chief engineer and J. F. Muir, office engineer. This staff at the present time numbers seventy.

Gravity System

The first contract was for one mile of 7-foot 6-inch circular monolithic concrete sewer with a wall thickness of 12 inches constructed in tunnel. This was awarded to the Nelson River Construction Company Limited of Winnipeg at a tender price of $40.00 per lineal foot.

The second contract was for approximately two miles of 7-foot 6-inch circular sewer of monolithic concrete in tunnel and was awarded to the Mutual Contractors Limited of Winnipeg, at a tender price of $36.00 per foot.

The third contract for 1,936 lineal feet of 7-foot 6-inch circular sewer, for 6,936 lineal feet of 6-foot 6-inch circular sewer, and for 4,146 lineal feet of 5-foot 6-inch circular sewer, all built of monolithic concrete in tunnel, was awarded to the Nelson River Construction Company Limited at tender prices of $30.00, $30.50 and $21.00 per lineal foot respectively.

In addition to the above the district has awarded four other contracts comprising the outfall sewer from the plant, and the secondary sewers. The approximate value of these contracts is $130,000.

Contracts covering the balance of the interceptor and practically all of the secondary sewers are now being tendered upon and it is expected that they will be let by December 15th, 1935. To date the value of the contracts awarded amounts to $1,080,000.

The Interceptor

The route of the interceptor is shown in Fig. 3 and it will carry to the main treatment plant the sewage from twenty sewer outlets now being discharged into the Red and Assiniboine rivers. This interceptor is designed to carry 245 million U.S. g.p.d. from an ultimate tributary population of 585,000. This is based on 247.5 U.S. g.p.c.p.d. being two and three-quarter times the average ultimate dry weather flow. The sewer was designed using a value of $C = 110$ in Hazen and Williams formula, this value being chosen because it was not known at the time whether brick would be a material of construction. It will be seen that by "crowding" the interceptor it can be made to carry considerably more sewage.

Types of Construction

Tenders were called for on the interceptor using four different types of construction:—

Type "A"—Monolithic alkali-resisting cement concrete.

Type "B"—Alkali-resisting cement concrete segmental tile jointed with alkali-resisting cement mortar.

Type "C"—Portland cement steam cured concrete segmental tile, jointed together with alkali-resisting cement mortar.

Type "D"—Hard burned brick jointed with alkali-resisting cement mortar.

It will be noticed that three of these types require alkali-resisting cement. This is the first large scale construction job using alkali-resisting cement as sold in Canada by the Canada Cement Company Limited under under the trade name "Kalicrete." This cement was specified owing to the rapid disintegration of Portland cement concrete in alkali soils. Accelerated tests extending over three years had been carried out by Mr. Archibald Blackie, F.C.I.C., consulting city chemist, and the alkali-resisting cement stood up exceptionally well while similar tests made on Portland cement showed rapid disintegration. The necessity for developing a concrete resistant to alkali action was recognized in Western Canada about the year 1920 when a committee consisting of engineers and chemists was appointed by The Engineering Institute of Canada to investigate the problem.

Tunnelling

Shafts have been put down at intervals and progress of work has been rapid.

Contract No. 2—The average progress in a typical week has been 10.0 lineal feet per day of three eight-hour shifts per heading (completed sewer).

Contract No. 3 and No. 4—The average progress in a typical week has been 6.33 lineal feet per day of two eight-hour shifts per heading (completed sewer).

The material that has been encountered so far is stiff blue clay having a weight of approximately 113 pounds per cubic foot. Excavation so far has been free from water trouble.

In contract No. 2, the earth is brought up the shaft by a hoist and bucket. In contract Nos. 3 and 4, a dumping elevator has been used. It is expected that these contracts will be completed by March 31st, 1936.

Treatment Plant

Specifications for the treatment plant equipment are now underway. The pumping station at the treatment plant initially will be provided with a capacity of 87 million U.S. g.p.d. against a 60-foot total dynamic head.

It is expected that clarifiers and sludge dewatering equipment will be provided in the initial plant.

The consulting engineer is making a very complete study of the chemical precipitation processes which have gained great favour in the United States in the past three years.

The treatment plant site in Old Kildonan has an area of 61.0 + acres.

DISCUSSION

T. C. Main, A.M.E.I.C.(1)

Mr. Main asked the following questions:—

As bacterial action practically ceases at 38 degrees F. and as ice cover in winter prevents absorption of oxygen by the river water, would it not require considerably more than 3.5 second feet per 1,000 population to prevent serious pollution under winter conditions?

Is not the land irrigation method of sewage treatment quite unsuitable for cold climates like ours?

About what proportion of Greater Winnipeg's spent water supply comes from wells?

How do you propose to take care of storm water?

E. V. Caton, M.E.I.C.(2)

Mr Caton inquired as to whether the pollution at Selkirk was greater than in the city or whether the rivers had started to recover before reaching that point.

N. M. Hall, M.E.I.C.(3)

Mr. Hall asked what should be done in the case of very small towns where the large scale methods would not likely be applicable.

L. Ostrander(4)

Mr Ostrander inquired as to whether two treatment plants and two interceptors, one serving, say, St. Vital,

(1) Assistant Engineer, Water Supply, Canadian National Railways, Winnipeg.

(2) Manager, Electric Utility, Winnipeg Electric Company, Winnipeg.

(3) Professor, Mechanical Engineering, University of Manitoba, Winnipeg.

(4) Assistant Engineer, Canadian National Railways, Winnipeg.

St. Boniface and Elmwood, on the east side of the river, and the other serving the municipalities on the west side of the river had been considered.

George Cole[5]

Mr. Cole outlined Dr. Dorr's early work in South Dakota and how he had come to develop the clarifiers for use in the cyanide process. This work had extended from the mining field to many others and went to show that developments in one field may be of advantage when applied to others.

W. M. Scott, M.E.I.C.[6]

Mr. Scott reviewed briefly the advance that had taken place in sewage treatment over the past twenty-five years. He thought that the engineer would do well to consider methods of treatment that had been recently developed on the Continent, especially Germany.

D. L. McLean, A.M.E.I.C.[7]

Mr. McLean congratulated the author on his paper and read the following remarks submitted by Mr. Aldridge by letter.

W. Aldridge[8]

(By letter.)

In discussing the virtues of sewage treatment for Winnipeg with a medical man, the writer was asked if all the pathological germs would be destroyed. What would be the right answer?

At the outset Mr. Hurst had stated that the reason why sewage is treated is because it may contain the germs of disease. By this he probably meant that the only really vital consideration urging treatment should be one of health.

However, actually this is not the case either historically or in practice. When the water closet was introduced in London a little better than one hundred years ago it resulted in over-charging of the family cesspool, which the householder was led to connect to the street gutter, or the closet itself was connected to the gutter. This led to covering the gutter or laying underground pipes and so the water carriage system was born. This pollution, buried from sight under the streets, only appeared in the small rivers and streams into which the pipes discharged. This water carriage idea led to the presence of all sorts of filth in the rivers. The government issued numerous regulations, and a great deal was done to "purify" the sewage. Germany followed England very closely. From then on a good deal is read about "disinfection of sewage." Sterilization, or complete removal of bacteria was not attempted.

On examination of the effluents it was found that the methods in use resulted in a large reduction of organisms as compared with the incoming sewage. Hence, since disinfection proved difficult and expensive, attention was given to reducing to a minimum the pathological germs in the effluent, but this was a side issue. The results attained were something like this:—

Sand filters: a reduction of	99.6 per cent
Sprinkling filters: a reduction of	86.6 per cent
Contact filters: a reduction of	40.0 per cent

Only sand filters reached 99 per cent under especially expert operation. However, Prescott & Winslow showed that "All these processes produce a certain reduction in bacterial numbers, but the decrease is not sufficient to be of very great sanitary moment. With a material containing so many bacteria as sewage, a reduction of 99 per cent may be satisfactory, but a reduction of 90 per cent is certainly not satisfactory." Hence, the effluent is chlorinated and all is assumed to be well. It may be good religion to overlook the ninety and nine and worry about the one, but what about the ninety and nine? They have gone into the sludge; but are they rendered harmless? Only Dr. Dunbar as far as the writer knows mentions this point. He found that typhoid bacilli remained active for thirty-three days in septic tanks, that bacilli in effluents spread throughout an irrigation farm area and that the draining from sludge beds acted similarly. However, he is satisfied to leave the subject there as no epidemic has been traced to this source.

He states that, "A complete separation or destruction of pathogenic germs is not, however, possible with any of the methods of purification which have been successfully adopted on a practical scale. Methods depending on heat and chemicals alone can be effective. Thermal disinfection can scarcely assume practical importance so one is left with chemical disinfection and this is not the same as chemical purification. Chlorine, as stated above, is the principal element used for this purpose but it is now applied for many other purposes, as for instance: controlling odours, relieving pooling of filters, reducing oxygen demand, correcting disturbances in activated sludge tanks and controlling fly breeding.

The disinfection factor has again assumed a secondary place and one must search closely to find any mention of disinfection or bacterial efficiency in such a book as T. P. Francis, on "Modern Sewage Treatment," for example.

From the practical side, as opposed to the historical development, Kinnicut, Winslow and Pratt, 1919, state: "The primary object of sewage purification is the oxidation of organic matters, its conversion into a stable form, so that it will not putrefy and create a nuisance. This end can often be attained by methods which do not effect a very notable reduction in the number of bacteria present."

And Metcalf and Eddy, after dealing with all the methods of purification covered by the paper state: "In all the processes of treatment previously outlined, the purpose has been mainly to prevent sewage causing a nuisance. If it is desirable to reduce the danger of transmitting disease by sewage-contaminated water to a minimum, the bacteria in the effluent must be killed before it is discharged into the water. This can be done by disinfection."

Again, "In the methods of sewage treatment, previously described a change in the character of the organic matter originally present is the main object sought, whereas in disinfection and sterilization the main object is to kill the bacteria in the liquids treated." But all this applied to effluents.

What about the ninety and nine not in this effluent? London sludge dumped into the sea contained 100,000,000 b. per c. c., one-half of which was assumed to be intestinal.

Drying beds are made over porous ground or are underdrained and a large amount of the water content drains off and travels long distances, and typhoid and dysentery germs will live three months in soil.

Experiments at the Chicago north side plant reported on last November showed that B. Typhosus persisted in sludge after eighty-three days and led to the conclusion that activated sludge at times may be very infectious. Caution should be observed when it is used as a fertilizer for truck gardens.

Fair and Wells in a paper on "Measurements of Atmospheric Pollution by Sewage Works" presented before the New Jersey Sewage Works Association last fall stated that "Trickling filters, activated sludge, pre-aeration tanks and aerated skimming tanks afford a relatively large measure of opportunity for contamination of air through the medium of evaporating droplets" and go on to give results of tests. Then what about flies?

The ordinary filter fly "psychoda alternata" is a poor weak body who never ventures far away. But the stable y, "stomoxys calcitrans," infested the filters at Green-

(5) Director of Mines Branch Province of Manitoba.

(6) Chairman of Commissioners, Greater Winnipe , Water District, Winnipeg.

(7) Assistant Chief Engineer, Greater Winnipeg Sanitary District.

(8) Assistant City Engineer, City of Winnipeg.

ville, S.C., last July and plant farmers had to cover their mules three miles away so as to protect them from bites. Milk production of cows fell off 50 per cent and even residents considered moving. All that was necessary was the proximity to the plant of cattle and sheep which acted as hosts for the breeding. Of course modern sanitation has reduced the chances of trouble, but when it does come, what? The question arises, does modern sewage treatment destroy the pathogenic bacteria?

W. D. Hurst, A.M.E.I.C.[9]

In reply to Mr. Main's questions the author stated that experiments elsewhere had indicated that considerably more dilution was required when ice cover prevented reaeration.

Land irrigation was undergoing a revival in Texas but he believed it was not suitable for conditions in Western Canada.

Surveys indicated that about 10 per cent of Greater Winnipeg's water supply came from wells.

The interceptor would carry up to 2.75 times the average dry weather flow to the treatment plant and regulators would by-pass the excess to the river.

In answer to Mr. Caton he remarked that the sanitary survey had not been carried any further north than Lockport as it was carried out with funds supplied by the Corporation of the City of Winnipeg and it was felt that a wider survey of the rivers was a problem that should be handled by the provincial government. However, as a matter of information, the survey was carried as far south as Emerson, Manitoba, and very bad conditions were found to obtain there, indicating pollution from the American side of the boundary. The pollution at Lockport was less than that at the Bergen cut-off just outside the city limits and it was thought that the river was beginning to recover at this point. It had not been deemed advisable to complain to the International Joint Commission concerning the pollution at the boundary as their obvious answer would be that the city and municipalities should clean up their own mess before complaining about someone else.

In reply to Mr. Hall he observed that in the past septic tank installations had been installed but modern practice considered that small mechanically cleaned sedimentation tanks provided with digesters would serve the purpose better, even though the initial cost might be higher.

In respect to Mr. Ostrander's inquiry, two separate plants had been considered but estimates made showed that a single interceptor and treatment plant with inverted syphons taking care of the municipalities on the east side of the river would be cheaper.

Mr. Aldridge's comments force the sanitary engineer to wonder whether the most important reason for the treatment of sewage is that of removing danger to health, or that of removing nuisance from the community affected. A community that is dumping raw sewage into a river from which another community down-stream takes its water supply is certainly creating a health hazard. If the condition of the water is such as to overload a municipal filter plant situated down-stream the second community may well insist that the first community construct a sewage treatment plant and the reason for its construction is primarily a health reason. The effluent from the plant may be sterilized with chlorine and the waters reach the second community in a sterile state at least as far as the first community is responsible for their being polluted.

If there are bathing beaches down-stream, the reason for sewage treatment is again a health reason or if there are valuable oyster fisheries and ice harvesting the reason is the same.

However, Mr. Aldridge suggests that the bacteria have been removed from the liquid and transferred to the solids, and still the danger to health remains. This may well be true and a discussion of this feature appears in the Sewage Works Journal for November, 1934, by C. C. Ruch-hoft, Bacteriologist, The Sanitary District of Chicago. He concludes that wet activated sludge cannot be considered innocuous and at times may be quite infectious. He also believes that caution should be observed when it is used as a fertilizer for truck gardens. However, sludge can be entirely freed from bacteria at a price. Milwaukee accomplishes this by vacuum filtration of the sludge, by heat drying it and making commercial fertilizer.

Great progress is also being made on the incineration of sewage sludge, and two plants are at present in operation, one at Dearborn, Michigan, the other at Chicago, Illinois.

If the supplementary fuel costs can be sufficiently lowered this process is likely to find widespread use.

The results on droplet infection from trickling filters, activated sludge pre-aeration tanks and aerated skimming tanks are still under study and judgment on their danger should be reserved.

The filter fly and the stable fly are troublesome when the trickling filter process is used and where apprehension is felt concerning this danger other processes should be given study.

The medical man can be safely told that all the pathogenic germs in sewage can be destroyed — at a price. It is the sanitary specialists' function along with the medical and other allied professions to appraise the value both social and economic of the complete removal of pathogenic organisms in sewage.

Both health and aesthetic reasons for the treatment of sewage are equally important where the receiving body is used for water supply, bathing, fisheries and ice-harvesting.

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[9] Assistant Engineer in charge of Waterworks, City of Winnipeg.

The Metallurgy of Metallic Arc Welding of Mild Steel

C. R. Whittemore, A.M.E.I.C.,
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Paper presented before the Junior Section of the Montreal Branch of The Engineering Institute of Canada, March 25th, 1935

SUMMARY.—A discussion on the difficulties of welding mild steel is followed by notes on the characteristics of the arc, the choice and suitability of various types of electrodes and the examination and structure of the weld metal in some actual welds, as shown by photomicrographs.

The metallurgical aspects of welding involve the consideration of the chemical and physical properties of the deposited weld metal and the effect of conditions of deposition on the parts joined. The properties of the welded joint depend upon the proper selection of equipment, materials and the control of the process to effect the joining of the parts.

The weld is composed of metal from two sources, viz., metal from the material being welded and metal from the electrode. The resultant weld is, therefore, affected by the parent metal, the electrode core and its coating or covering and to some extent by the procedure followed.

An ideal welded joint is one in which the properties of the weld metal and the base metal are similar in chemical composition and physical properties. A joint of this type is readily attainable if the structure demands it. Joints subjected to dynamic stress, e.g., pressure vessels, require weld metal of the highest quality, whereas in a structure subjected to static loads only, the weld metal will not require the same degree of ductility and resistance to impact. It will, however, be necessary to develop full tensile strength and a sound weld.

Materials

In the metallic arc welding of mild steel nearly every one at some time or other has experienced difficulty in its welding and to overcome this attempts have been made to define by specification the quality of steel suitable for welding. To date, such a specification has not been evolved but it is the opinion, based on practical experience, of those concerned with the choice of materials that steels conforming to those enumerated under American Society for Testing Materials Serial designation A151-33 are suitable for fusion welding being mindful of the fact that welding technique is of fundamental importance. This specification lists some twenty separate A.S.T.M. specifications and includes those for structural steel for bridges, buildings, ship plate, locomotive boiler and firebox steel, etc.

Plate meeting these specifications will have a tensile strength of 45,000 to 72,000 pounds per square inch with a carbon content of 0.12 to 0.30 per cent, depending on requirements and plate thickness. Steels up to 0.35 per cent carbon have been welded with satisfactory results under usual commercial practice.

Other steels may be metallic-arc welded with satisfactory results when suitable fluxes and filler metal are used in conjunction with correct technique.

Steels having a carbon range of 0.10 to 0.35 per cent, with a manganese content of 0.30 to 0.60 per cent, sulphur and phosphorus each 0.05 per cent maximum and made by good, basic or acid open-hearth practice, will present no difficulty in metallic arc welding. Such steel will be free from detrimental amounts and types of non-metallic inclusions, gases and segregations. There is no reason why steels below 0.10 per cent carbon cannot be welded if due care has been observed in the manufacture of the steel but it has been our experience that steel under this carbon content contains more non-metallic inclusions and absorbed gases, than steel higher in carbon.

The surface condition of the plate is also important from a welding viewpoint. A plate with a heavy red oxide scale is not as satisfactory as one with a light blue scale, as the heavy red scale offers more resistance to the arc.

The effect of segregation or lamination in plate on the deposited weld metal is shown in Fig. 1 (lower half). Note the small hole at the line of fusion where sulphur segregation is shown by the dark lines.

Electrodes

A metallic arc welding electrode is a metal wire of definite diameter, length and suitable composition used as a terminal in an electric circuit to produce an arc through which the filler material (the electrode) is carried in the molten state and fused between the parts to be joined. In metallic arc welding it is necessary that the surface of the electrode be coated or heavily covered with suitable metal fluxing materials for the purpose of stabilizing the arc and protecting the metal from atmospheric contamination during transfer and upon deposition.

Theories of Metal Transfer

Whether the deposited metal passes through the arc as vapour, mist or globules, has long been under discussion, as has also the driving force.

One of the first theories advanced was that the metal was transferred as vapour which formed at the tip of the electrode and condensed in the crater of the work. Others have pointed out that this may be only partially true since a large amount of energy would be necessary to vaporize the metal, and it was concluded that the larger part of the metal must be transferred as mist or globules of molten metal. This has been found to be the case.

As to the method of transfer, some have attributed the driving force to the evolution of gas within the melting tip, which carried particles of metal with it; others to the forces of adhesion and surface tension between the molten metal on the tip and that in the crater.

A comparatively new theory as applied to electric welding is the "pinch effect" which accounts for the force necessary to separate the globules. The "pinch effect" is the local contraction of the cross-section of a liquid resistor through which electric current is passing and in which heat is being generated. In an open path this contraction results in complete rupture. This contraction is caused by an electromagnetic force that acts from the circumference to the centre of the conductor and in a direction perpendicular to the axis. The ejecting force increases as the square of the current and diminishes with an increase in the cross-section of the conductor. In the filament formed, as the

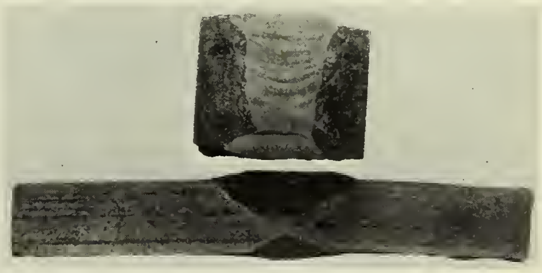

Fig. 1—The effect of Segregation or Lamination in Plate on the Deposited Weld Metal.

Effect of Arc Voltage on Chemical Composition of Weld Metal
Ref. F. R. Hensel and E. I. Larsen, Westinghouse
3/16″ Bare Electrode—190 Amps.

Arc Voltage	C	Mn	P	S	Si	N_2
13 volts.....	.02	.25	.010	.023	.014	.114
18 volts.....	.01	.11	.013	.025	.003	.121
24 volts.....	.03	.03	.010	.012	.006	.126
30 volts.....	.03	.05	.014	.020	.005	.135

Fig. 2.

globule is about to be separated, there is a tremendous current density producing a high pressure of vaporized and ionized metal which propels the globule.

It seems that all the above factors combine to effect the deposition of metal. To weld in the vertical and overhead positions it would appear that the explosive force of the gas formed and the "pinch effect" are necessary to overcome the force of gravity.

Arc Voltage

The voltage drop across the arc is influenced by the arc length and by the resistance of the incandescent vapour forming the arc. The arc voltage, which is a function of the arc length, is one of the major variables influencing the deposited metal. The effect of arc length on the chemical composition of weld metal deposited by a 3/16-inch diameter "bare" (sull-coat) electrode is shown by Fig. 2.

Figure 3 shows the effect of arc voltage on the nitrogen content and ultimate strength of weld metal deposited by a 3/16-inch diameter "bare" electrode.

Arc Stability

The significance of arc stability may be summarized as follows:

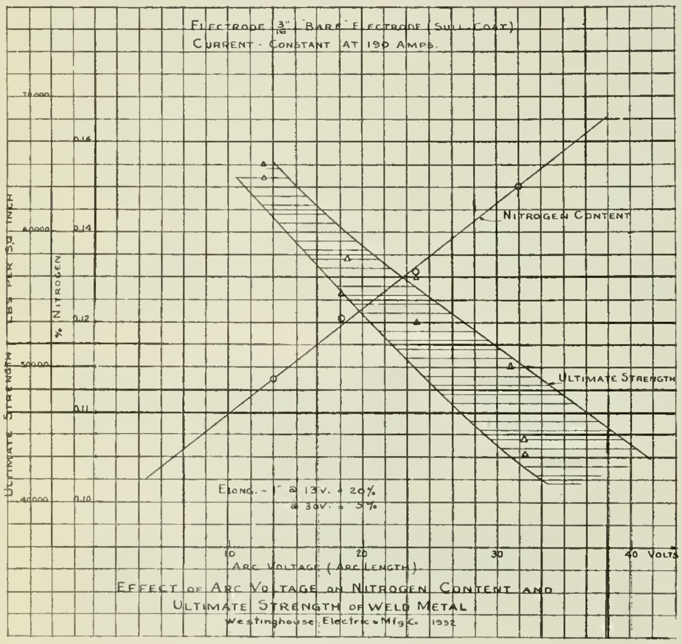

Fig. 3.—Effect of Arc Voltage on Nitrogen Content and Ultimate Strength of Weld Metal.

(1) Ease of operation.
(2) A regular flow of small particles across the arc.
(3) A shorter arc resulting in a sounder weld (less slag inclusion, less porosity and less contamination from oxide and nitride).
(4) Less loss of metal from sputtering.

Arc Current and Electrode Size

It is difficult to give definite figures covering current, speed, etc., on account of the conditions under which the work is done, the character of the work and skill of the operator.

The following tables give the current range, consistent with good results, for "bare" and lightly coated metallic electrodes and for heavily covered electrodes for downhand welding of mild steel.

Current and Arc Voltage—Heavily Covered Electrodes

Electrode Diameter in Inches	All Mineral Coating		Braided Type		Mineral and Cellulosic Compound	
	Amperes	Arc Voltage	Amperes	Arc Voltage	Amperes	Arc Voltage
5/32	125-160	25-28	150-180	30-35	110-170	21-25
3/16	160-240	25-28	180 225	33-38	150-200	30-34
1/4	240-375	28-32	225-300	35-40	225-275	33-37
5/16	375-500	28-32	300-400	38-42	325-375	36-40
3/8	500-650	30-33	400-500	38-42	425-475	43-47

Bare and Lightly Coated Electrodes

Electrode Diameter in Inches	Amperes Hand Welding	Arc Voltage	Amperes Automatic
1/8	120–150	15–17	130–175
5/32	150–175	17–19	175–225
3/16	160–220	19–22	225–275
1/4	200–275	19–22	275–325

Fig. 4.

It will be noted that a higher arc voltage is required for heavily covered electrodes. This is due, in part, to the gas around the arc and partly to the actual increase in arc length which is necessary to keep the coating from touching the metal pool and causing porosity.

Polarity

In general, heavily coated electrodes are connected to the positive pole, and the work to the negative pole, usually referred to as "reversed polarity." Bare wire or lightly coated electrodes are connected to the negative pole and the work to the positive pole, "straight polarity."

Factors Governing the Performance of Mild Steel Electrodes

It was previously stated that the deposition of electrode metal takes place in the form of drops. Investigators have also shown that satisfactory electrode performance is conditioned upon the regularity of the drops. During the brief existence of each drop two periods may be noted, namely, the formation period and the transfer or short circuit period.

The difference in performance of two electrodes of the same diameter and surface finish, but of different composition, is found in the relationship of the formation and transfer periods. The relationship is a function of the volume, temperature and surface tension of the individual drops.

The ability of the electrode to perform depends upon the following factors:—

(*a*) Chemical composition.
(*b*) Freedom from impurities.
(*c*) Grain structure.
(*d*) Surface finish.

Electrode Coatings

As previously stated it is very essential that all metallic electrodes have some type of coating or covering in order to obtain stabilization of the arc for protection of the arc stream from the atmosphere.

Electrode coatings may be conveniently divided into four types according to their respective thicknesses.

(a) Surface finish—so-called "bare" electrode.
(b) Light coatings (dipped) .001 inch to .02 inch.
(c) Medium coatings (dipped and extruded) .025 inch to .035 inch.
(d) Heavy coverings (extruded, wrapped, or braided) .035 inch to .060 inch.

Mild Steel Welding Wire and Weld Metal Analysis

	C	Mn	Si	S	P	O_2	N_2
1. Electrode (Base Rod.)...	0.11	0.45	.03	.04	.03	Nil.	Nil.
2. Base Rod......	.13-.18	.40-.60	.06 max.	.04	.04	Nil.	Nil.
1. Deposit (Bare)........	0.03	0.04	.005	.03	.02	0.20	0.13
2. Deposit (Bare)........	.03-.08	.10-.20	.03 .05	.04	.04	.20-.30	.10-.14
Deposit (Covered).....	.08-.17	.30-.50	.10-.15	.04	.04	.025-.04	.014-.02
Boiler Plate...	.15-.20	.35-.60	....	.05	.04	....	.009

Fig. 5.

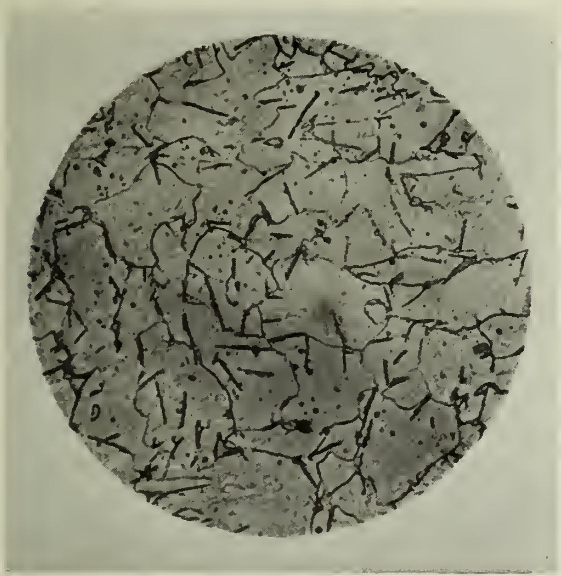

Fig. 6.

The above thickness values, for any one type, vary with the diameter of the core wire and to some extent with the composition of the coating or covering and the application of the electrode.

Effect of Electrode Coatings and Coverings on the Chemical and Physical Properties of Deposited Metal

During the melting of an electrode, it was pointed out that the metal crossing the arc was in a finely divided form

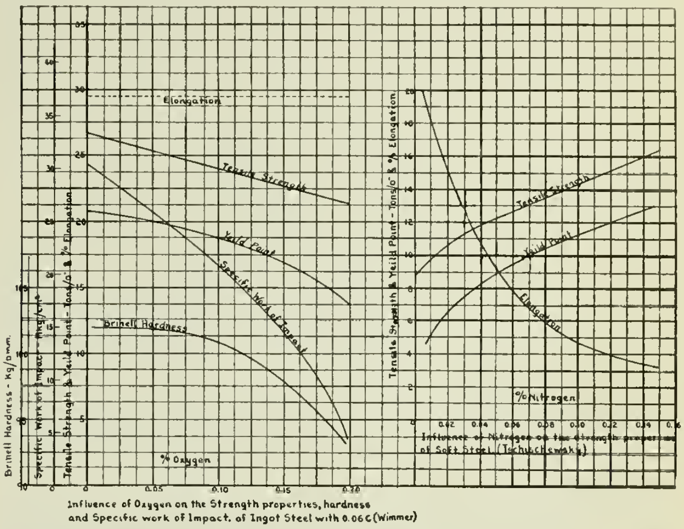

Fig. 7—Influence of Oxygen on the Strength Properties of Steel.

and at an extremely high temperature (3,700 degrees C.). In this condition the metal undergoes considerable chemical change, first, through volatilization and oxidation of some of the constituent elements of the steel core; second, the properties of the deposited metal are affected by the introduction of atmospheric gases in combination with elements of the former and also in solid solution.

The degree to which chemical and physical changes occur will vary with the type and efficiency of the coating or covering.

Typical analyses of deposits made with the so-called "bare" electrode and covered electrode will demonstrate the advantage attached to adequate protection.

The bare electrode weld metal is low in carbon, manganese and silicon due to oxidation and volatilization of these elements.

The contaminating influence of the atmosphere is indicated by the high oxygen and nitrogen contents. The

Physical Characteristics of Weld Metal Deposited by Protected and Unprotected Arc

Electrode Type	Yield lbs. per sq. in.	Tensile lbs. per sq. in.	Elong. 2 in.-per cent	R of A.	Impact Charpy ft. lbs.	Fatigue	Density	Corr. Res.
Boiler plate........................	27,500-32,500	55,000-65,000	24	45.0	26.0	26,000-28,000	7.84	Good.
1. Mineral coating and cellulosic material not stress relieved..................		65,000-75,000	20-30	....	30-40	28,000-32,000 lbs. per sq. in.	7.80-7.83	Good.
2. Mineral coating and braiding. not stress relieved......................	50,500-60,300	67,400-71,300	24.5-30.0	....	30-40	....	7.80-7.83	
Stress relieved at 1,200 degrees F.....	50,800-56,600	65,400-66,700	29.5-34.5	....	....	....	....	
3. Mineral coating and reducing and gas forming materials..................	54,850-62,500	61,250-67,900	27.0-32.5	48.3-59.8	....	....	7.81-7.83	
4. All-Mineral coating.................	50,000-53,000	65,000-70,000	30-35	50-57	....	....	....	
5. All-Mineral coating.................	50,000-55,000	65,000-85,000	20.0-35.0	35-50	30-35	28,000-30,000		
A. Bare or lightly coated. (Unprotected)	....	45,000-65,000	5-8	....	3-8	15,000-18,000 lbs. per sq. in.	7.4-7.7	Poor.
B. do.	....	59,324	4	11.9	....	....	....	
B. do.	....	62,872	7	19.7	....	....	....	
C. do.	28,000-32,000	45,000-55,000	5-10	2-5	5-13	12,000-16,000 lbs. per sq. in.	....	Poor.
D. do.	42,000-45,000	60,700-54,850	7-10	16.9	....	....	7.6	

Base Rod: C—.13-.18 Mn—.40-.60 S—.04 P—.03

Fig. 8.

nitrogen often appears as needles within the crystal. Figure 6 shows the presence of nitrogen needles at a magnification of 500 diameters.

At the grain boundary a dark constituent is evident which is probably an oxide-nitrogen-carbide compound of extreme brittleness. The presence of such a material would cause low impact strength and low ductility which is characteristic of "bare" wire welds.

Molten metal in the presence of oxygen forms its corresponding oxide which dissolves and causes brittleness on solidification. The effect of oxygen on "bare" wire weld metal is extremely active as shown by the fact that the electrode wire has a carbon content of .13 to .18 per cent and the resulting weld metal 0.02 to 0.04 per cent carbon. The iron oxide reacts with the carbon forming carbon monoxide, bubbles of which are entrapped to some extent during solidification, resulting in a porous weld.

Welds made with heavily covered electrodes are practically free from nitrogen and oxygen.

The influence of oxygen and nitrogen on the physical properties of low carbon steel are shown in Fig. 7.

The physical properties of weld metal deposited by "bare" or lightly coated electrodes and heavily coated electrodes are shown in Fig. 8.

Bare and lightly coated electrode weld metal has low ductility, low specific gravity, low impact resistance and low corrosive resistance because of the presence of oxides and nitrides.

An important function which can only be fulfilled by the use of flux-covered electrodes is the control of chemical analyses and physical properties of the deposited metal. Increase in carbon, manganese and silicon content with a decrease in the nitrogen and oxygen content account for the improved physical properties of weld metal. The density or specific gravity, indicative of porosity, of covered electrode weld metal is practically equal to that of the best grade of boiler plate.

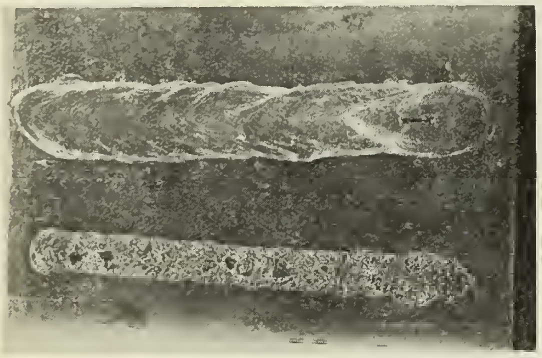

Fig. 9—Corrosion Test on "Bare" and Covered Electrode.

The resistance of covered electrode weld metal to corrosion is comparable to that of the parent metal whereas the resistance of bare wire weld metal is quite inferior. The specimen shown in Fig. 9 was immersed in hot 1:1 hydrochloric acid for twenty-four hours.

Weld Structure

The deposition of metal by the metallic arc process is somewhat analogous to electric melting and casting. The fundamental principles governing good or poor metal in the molten condition are essentially the same. If in an electric furnace the metal was melted down under oxidizing conditions and had a slag of unsuitable viscosity, quantity, and was somewhat inactive, the resultant ingot would be porous, segregated and of little value. In the case of the welder he may obtain weld metal of the same poor quality by non-observance of the proper current, arc voltage, manipulation or by the use of an unsuitable electrode.

Since the greater percentage of welding is on steel having a carbon range of 0.10 to 0.35 per cent, we shall consider the structure of welds made on material of this class.

The deposition of metal in a single layer is essentially a cast structure but in multiple layers complex metallurgical effects result. The factors of current, arc voltage and of time control the temperature gradient of the plate from the melting point downwards and thereby produce pronounced changes on the weld structure and metal adjacent to the weld.

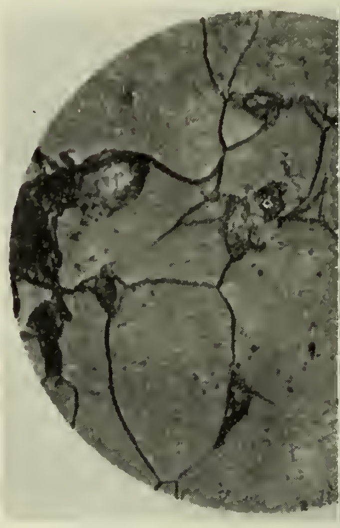
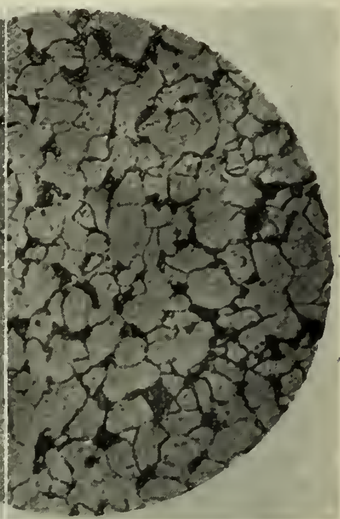

Fig. 10—Mag. 500X. **Fig. 11—Mag. 500X.**

Structural Examination

The structure of weld metal may be determined by the application of micrography and macrography which are supplementary to each other.

Micrography is the examination by means of a microscope of a specially prepared and representative specimen, which is necessarily confined to a small area.

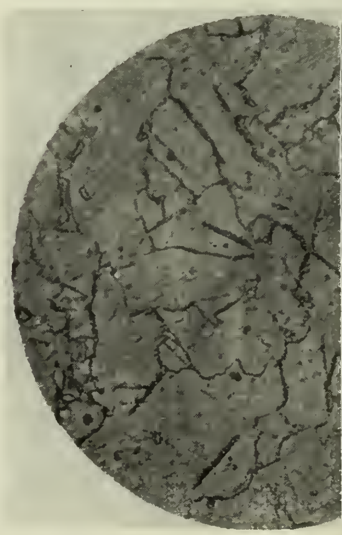
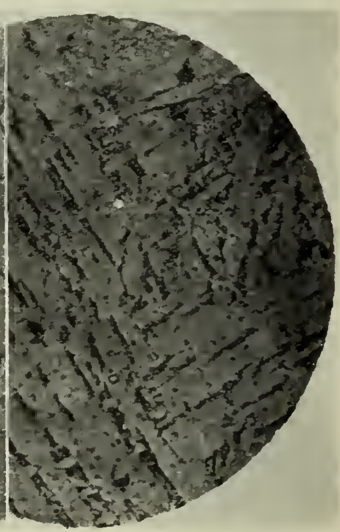

Fig. 12—Mag. 500X. **Fix. 13—Mag. 500X.**

Macrography is the examination of a properly prepared specimen under a very low magnification or with the naked eye, as for example in Fig. 1.

Macro examination of a weld will reveal the following conditions:—

(*a*) The number of layers of metal and manner in which they have been deposited.
(*b*) Excessive, or lack of, penetration of weld metal.
(*c*) Lack of fusion along the side walls and between runs.
(*d*) Porosity.
(*e*) Inclusions of slag, oxide, etc.

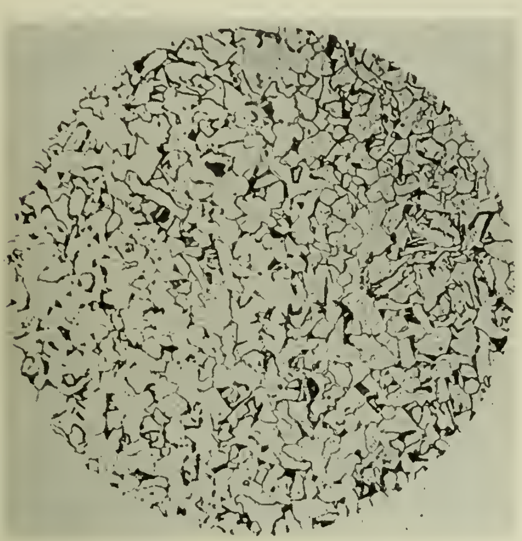

Fig. 14—Mag. 100X.

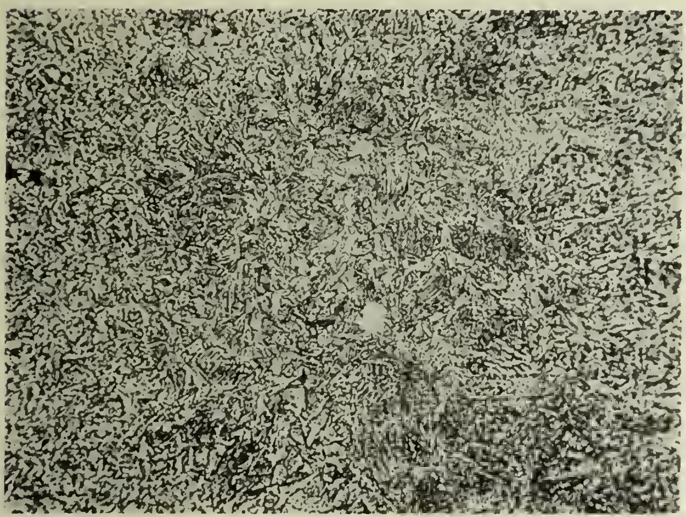

Fig. 15—Mag. 100X.

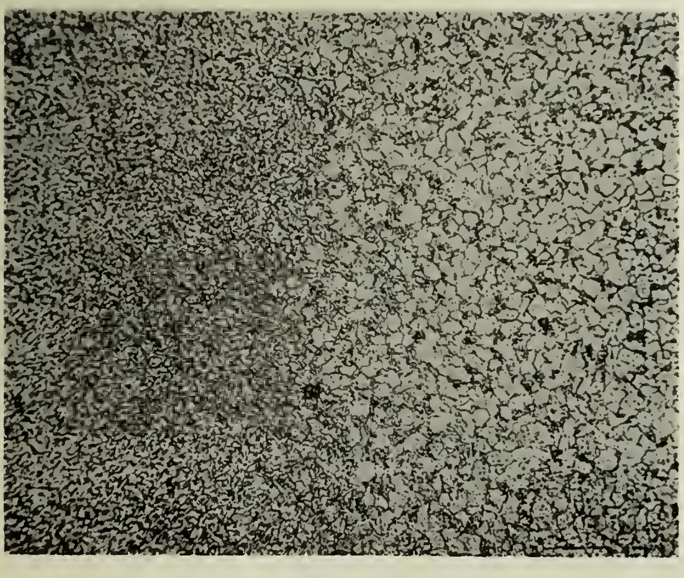

Fig. 16—Mag. 100X.

Micro Structure of Low-Carbon Metallic Arc Welds

The solidification of weld metal results in the formation of a "columnar" structure due to rapid cooling when the metal is deposited in a single layer. In multiple layer welding each layer modifies the structure of the preceding and a knowledge of these changes and factors contributing to them is of fundamental importance in the deposition of weld metal as also the degree to which the parent metal is affected.

The structure typical of weld metal deposited by the metallic arc process is illustrated by the following examples.

"Bare" Wire Weld Metal (see Figs. 10 to 13).—The weld metal was deposited in a 90-degree Vee on a ⅜-inch plate having a chemical analysis of 0.25 per cent C., Mn. 0.377, P. .028. The joint was made in three layers with a ⅛-inch diameter sull-coated electrode, .18 per cent C. and operated at 125 amperes and arc voltage 17. The electrode was negative. The tensile strength of the weld metal was 61,000 pounds per square inch.

Figure 10 shows the structure of the parent metal which is that of ordinary hot rolled steel finished at a high rolling temperature.

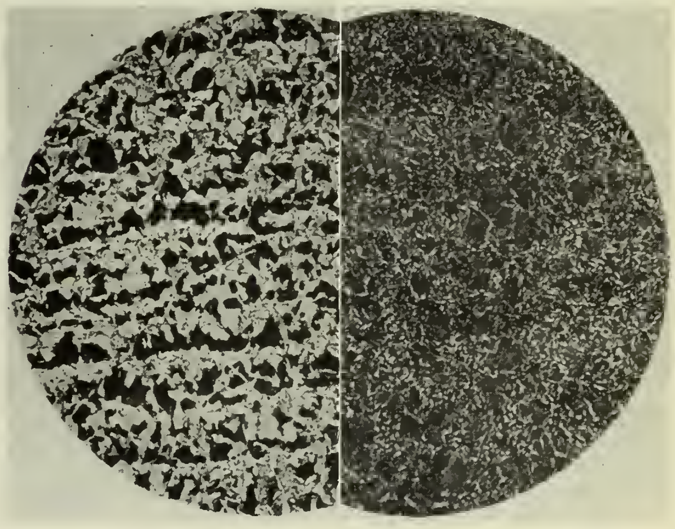

Fig. 17—Mag. 100X. **Fig. 18—Mag. 100X.**

Figure 11 shows the structure adjacent to the weld metal deposited in the first pass. The grain size has actually been refined and indicates a temperature of 1,525-1,550 degrees F. within the thermo-critical range.

Figure 12 represents the structure of the first pass which has been altered by the heat effects of subsequent layers. The structure shows the so-called nitride needles and segregation along the grain boundaries.

Figure 13 is the characteristic structure of a single pass weld. The grain structure is coarse and greater segregation of impurities result.

Covered Electrode Weld Metal (see Figs. 14 to 20). —Figure 14 represents the structure of blue annealed 12 gauge sheet having an analysis of C. 0.17 per cent, P. 0.013 per cent, Mn. 0.45 per cent, S. 0.032 per cent, with physical properties of 41,340 pounds per square inch elastic limit, 58,470 pounds per square inch ultimate and 22.5 per cent elongation in 8 inches.

The grain structure and distribution of pearlite (dark areas) are uniform, the light areas are ferrite in excess of that required to form pearlite.

Figure 15 represents the weld structure formed by automatic butt welding of this material with a heavily covered electrode at 160 amperes, an arc voltage of 25 and speed of 14-16 inches per minute.

The structure is Widmanstatten in character, typical of single layer deposition and indicative of primary crystallization.

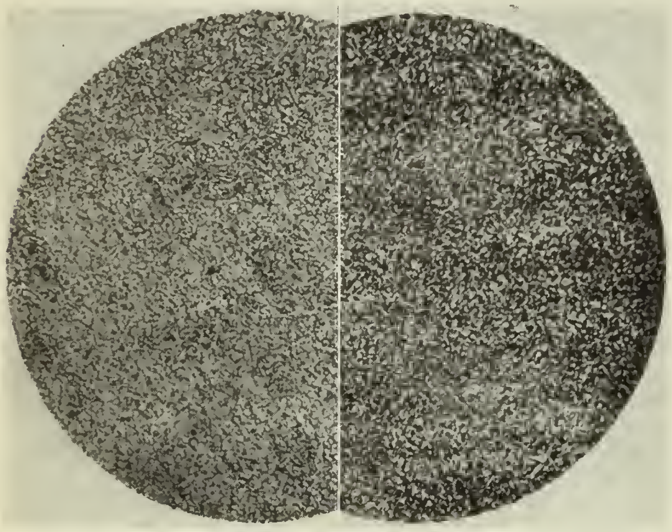

Fig. 19—Mag. 100X. Fig. 20—Mag. 100X.

The weld metal analyzed 0.10 per cent C., 0.47 per cent Mn., 0.02 per cent Al_2O_3.

Figure 16 shows the transformed area adjacent to the weld. In this area a recrystallization has taken place and the grain structure is somewhat smaller than that of the parent metal.

Figure 17 represents the structure of 1¼-inch plate having an analysis of C. 0.33 per cent, Mn. 0.49 per cent, P. 0.029 per cent, S. 0.019 per cent, Si. 0.20 per cent, with physical properties of 45,330 pounds per square inch, elastic limit, 79,300 pounds per square inch ultimate, 30 per cent elongation in 2 inches, reduction of area 48 per cent and Brinell hardness 163.

A U-type of groove was used and the weld metal deposited in eleven layers, using a 3/16-inch diameter electrode and 220 amperes for the first pass and ¼-inch diameter electrode and 360 amperes for subsequent passes. The back was chipped out and two passes laid down using a 3/16-inch diameter electrode.

After welding the structure was stress relieved at 1,200 degrees F. for one hour per inch of thickness.

Figure 18 represents the transformation zone next to the parent metal.

Figure 19 is the area adjacent to the weld and has a sorbitic structure.

Figure 20 shows the structure of the weld metal which is typical throughout the cross-section except for the top and bottom passes.

From the photomicrographs shown it is apparent that the conditions of heating and cooling, which are produced in the material adjacent to the welding zone, give rise to an infinite number of structural forms as the temperature gradient ranges from normal to the melting point of steel.

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The Boulder Dam - Los Angeles Transmission Lines

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Paper presented before the Niagara Peninsula Branch of The Engineering Institute of Canada on October 22nd, 1935.

SUMMARY.—After giving engineering particulars of this 270-mile, 287-kv. transmission line, the paper discusses the concentric type of conductor employed, with respect to manufacture, corona loss, vibration and jointing.

The Colorado river is one of those rivers which have been both a curse and a blessing. Boulder dam is intended to remove the one and to add to the other. It drains approximately 240,000 square miles with an average annual run-off of about 16,000,000 acre feet (varying from 4,000,000 to 24,000,000 acre feet). Couple this tremendous variation with a great seasonal variation (there being but little natural storage and a consequent sudden run-off) and the necessity for some control is apparent. The serious floods and the tremendous silting up of the channel in the lower reaches, with the resultant dyke expense, demanded some action.

The Black Canyon of the Colorado, where the Boulder dam is being built, is located about 150 miles down stream from the Grand Canyon. It is on the border of Nevada and Arizona near the south-west corner of Utah and quite close to one corner of California. The project is for the purpose of water storage for (*a*) river control, (*b*) water supply and irrigation, (*c*) electric power.

The Boulder dam must be considered in conjunction with the Colorado river aqueduct fed from the Colorado river about 150 miles downstream at the Parker dam. This aqueduct is a larger project than the Boulder dam (some $225,000,000 as compared with $185,000,000) but does not receive the same publicity. The necessity of the aqueduct is due to the water situation in Southern California, particularly in the metropolitan water district in and around the city of Los Angeles. As the population of the Southern California Pacific slope is growing, the existing water supplies are proving increasingly inadequate. Nature even now (with only 15 inches annual precipitation) is not replacing water as rapidly as man is withdrawing it. The Boulder dam's 30,000,000 acre feet capacity will compensate for the smaller capacity of the Parker dam, about 700,000 acre feet. It is a necessary factor in the Parker dam and Colorado river aqueduct project.

With these thoughts in mind it will be appreciated that the Boulder dam involves a great deal more than the development of cheap hydro-electric power, and those in the electrical industry must not judge this immense project purely from their own viewpoint.

Fig. 1—Location of Boulder Dam in Southern California.

However, this article deals particularly with the electrical side. The United States government sells the water in the penstocks to the generating interests at 1.63 mills per kilowatt hour for firm power and 0.5 mill for secondary power, also installing the generating apparatus but recovering the cost thereof in instalments.

The site eventually will be able to develop 1,800,000 h.p., four machines of 115,000 h.p. each now being under construction.

The first block of power is 240,000 kv.a. contracted for by the City of Los Angeles Department of Water and Power and it is the transmission of this power from the dam to Los Angeles that is to receive attention in this paper.

Later blocks of power will be taken, one to pump the water over the mountains in the aqueduct project mentioned above, the Metropolitan Water District of Los Angeles (not to be confused with the Department of Water and Power) being the purchaser. A third lot will go to the Southern California Edison.

In neither of these latter cases is absolute continuity of service so essential as with the Department of Water and Power, the Southern California Edison block being supplementary to steam and local hydro-electric developments, and the aqueduct having large water reservoirs close to Los Angeles which would render even a comparatively long power interruption not serious.

In the case of the Department of Water and Power, however, absolute dependability is of utmost importance and pains have been taken toward ensuring only the best of constructions.

Due to the magnitude of this project and the conditions involved large sums of money and time have been spent on research to see that the right thing is done and that continuity of service is ensured.

The dam itself will rise 730 feet above bed rock and will be 1,180 feet long by 43 feet wide at the crest. It is keyed into slots cut in the rock on each side of the canyon although due to its 650-foot thick section at the base it will be stable of itself even against the relatively great head of water involved.

During construction, the river is being diverted through four 50-foot diameter by one-mile-long tunnels cut in the solid rock. These tunnels, or rather the lower ends of them, will be used later for spillway and discharge outlets.

Spillways, one on each side of the river, will be for flood control and will connect through 50-foot tunnels to the down-stream ends of the diversion tunnels mentioned above. It should be noted that water will not flow over the crest of the dam, the dam being designed on that basis due to the high temperature to which the concrete is subjected on the down stream face. It is feared that if water were to flow over the face of this concrete it would result in destructive stresses at the surface of the concrete.

The power houses will lie at the bottom of the downstream face of the dam and on both sides of the river.

The Boulder dam is 271 miles from Los Angeles, the intervening country being desert and low mountains as far as Cajon Pass, a distance of 231 miles, and thence 40 miles of coastal slope to the city. The characters of these sections have resulted in different types of transmission line construction as will be shown later.

As mentioned before, the block of power under present discussion is 240,000 kv.a. This is to be transmitted 271 miles at 287,000 volts sending end, 275,000 volts (grounded neutral) receiving end on two three-phase lines of 512,000 c.m. copper. It is said that this would be equivalent to three 220-kv. lines. Overhead ground wires and counterpoises are used throughout, average spans 1,000 feet.

Transmission Lines

The transmission line will cost $13,700,000 or a cost of about $25,300 per circuit mile.

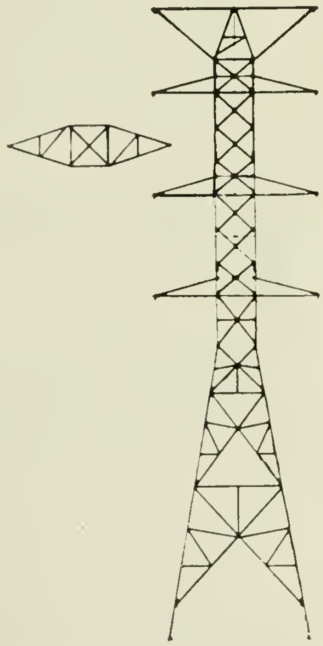

Fig. 2—Double Circuit Tower, Coastal District.

In the 40-mile coastal district a single line of double circuit towers will be used. These towers are of standard construction and of the following dimensions.

Each tower:
- Height—144 feet 2 inches.
- Conductor spacing—24 feet 6 inches vertically in a plane.
- Circuit spacing—40 feet 6 inches.
- Height to lowest cross-arm—75 feet.

Weight—23,000 pounds.
Insulator strings—approx. 12 feet long.
Ground wires—2 lines 7/16 inch e.h.t. copper-weld steel on 40-foot 2-inch centres.

There will be two hundred and seventy-one towers in this district.

In the desert section, of 231 miles, a double line of single circuit towers is being employed. Switching stations

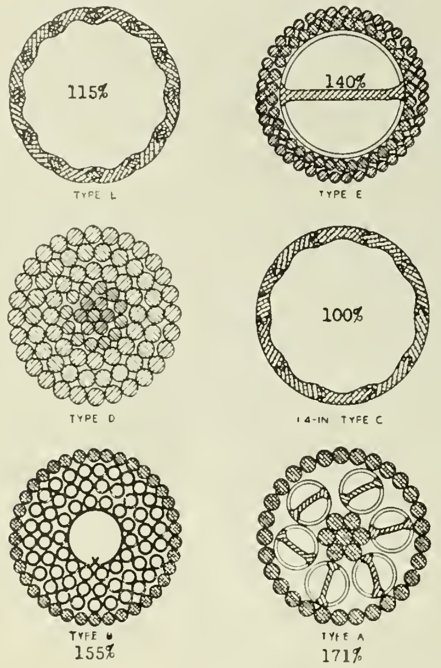

Fig. 3—Comparison of Weights for some Outside Diameters. Weights Expressed in Per Cent of 1.4 inch Type C (Type HH).

are being set up at about 90-mile intervals to permit cutting out sections of either line for maintenance or emergency purposes.

Each tower:
Height—109 feet 2 inches.
Conductor spacing—32 feet 6 inches horizontally.
Circuit spacing (tower line, centres)—265 feet standard.
Height to cross-arm—90 feet.
Weight—18,000 pounds.
Number—2,530.
Ground wires—2 per line (4 total).
—½-inch galvanized steel on 50-foot centres.

The base is rotated 45 degrees from the normal which results in an approximate saving of 10 per cent in weight.

Counterpoise systems normally are either of the crowsfoot type or parallel type. This is a combination of both, a double line of ½-inch black copper rod extending along each tower line and cross connected at each tower. It is just another evidence of extreme factors of safety in design on account of the importance of 100 per cent service from the line. About 4,000,000 pounds of copper were used in this counterpoise system.

Conductors

A highly important element in the transmission line is of course the conductor. On account of breaking new ground in the voltage range, and due to the amount of material involved, a variety of conductors have been studied.

In selecting a conductor in the upper voltage ranges one must consider two factors from the viewpoint of losses:—

1st—The cross-sectional area must be sufficiently large to keep the $I^2 R$ losses within proper limits but should not be larger than that amount or the best economy in use of metal is not attained. Cost of power and cost of metal are the determining elements in this first division of the problem.

2nd—The outside diameter must be such that for the voltage, spacing, altitude and kind of conductor surface the corona loss does not become excessive. Corona is that pale blue discharge accompanied by a rustling sound developed around a conductor if the voltage stress in the surrounding air rises above a certain critical value, the critical value depending on conditions. The production of this corona absorbs an appreciable amount of power and must be given proper consideration when designing a line.

Increasing conductor diameter (other conditions being equal) is the common method of reducing excessive corona loss.

So long as condition "one" (economical resistance loss) results in condition "two" (economical corona loss) being fulfilled one has an economical design without waste of metal. If, in order to meet corona loss consideration, more metal is employed than resistance loss necessitates one does not have the most economical design and good engineering requires a better metal efficiency.

This search for the efficient use of the conductor metal led the Los Angeles engineers to study a wide variety of conductor designs, from the conventional concentric stranded and the internally supported expanded sections to the finally selected type HH. (See Fig. 3.) With this construction one can engineer properly the conductor design for resistance loss and corona loss independently of each other between quite wide limits; this by increasing the thickness of the wall while maintaining the same outside diameter; or by adjusting the wall thickness while maintaining the same cross-sectional area and varying the outside diameter.

This design of conductor has an important characteristic from the corona viewpoint of which full advantage was not taken in this particular transmission line. It is well known that a smooth cylindrical surface is the most resistant to the formation of corona. Any unevenness on such a surface aids the formation of corona. An inspection of the surface of the type HH conductor shows it approximates very closely to a smooth cylinder whereas the conventional stranding has a large number of serrations.

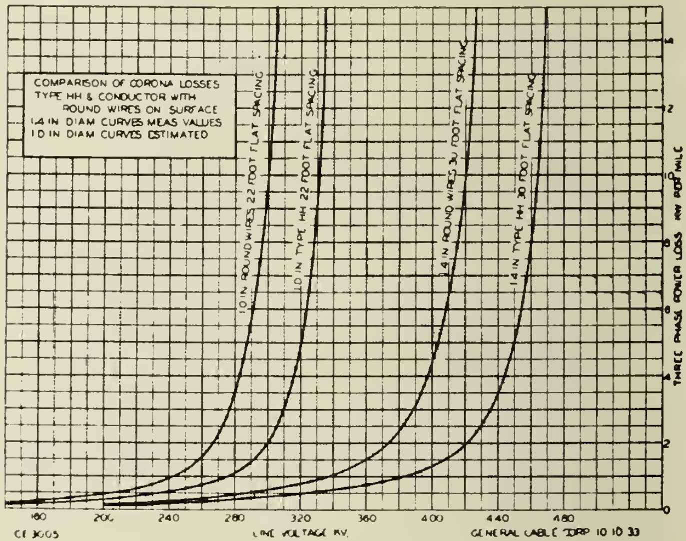

Fig. 4—Comparison of Corona Losses.

It has been proved by extensive experiments that for a given diameter the type HH loss is much lower than that of the conventional. (See Fig. 4.) Or if the economical corona loss has been determined a smaller diameter conductor may be chosen for HH than for conventional. In the case of Los Angeles this would have permitted a still smaller cross-sectional area for HH than was used if it had been so desired. This would have reduced the conductor weight to about 83 per cent of the chosen value.

In examining a type HH conductor the interlocking structure essential to prevent any "bird-caging" during handling should be noted. Some idea of its strength under crushing may be gained from an actual experience where one flange of a two-ton reel dropped on top of a 1.1 inch o.d. 500,000 c.m. type HH cable. The conductor was dented seriously but did not collapse. In fact, as it was an experimental length, it was pulled up on the line and the location is not detectable from the ground.

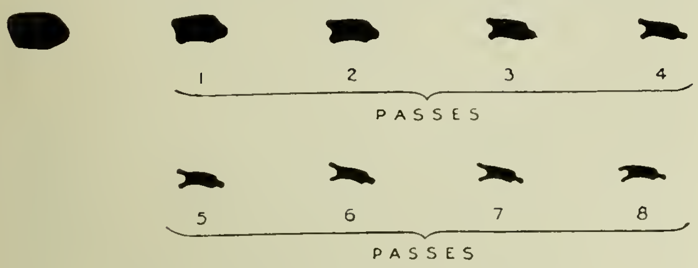

Fig. 5—Steps in Drawing Down Segments.

The Boulder dam-Los Angeles conductor is a 512,000 c.m. hard copper type HH hollow conductor of 1.4 inch o.d.

There are ten tongue and groove segments of 28-inch lay.

Ultimate strength	21,600 pounds.
Normal spans	1,000 feet.
Normal max. sag	46 feet.
Normal max. stress	40 per cent of ultimate.
Loading—Coastal	12-pound wind at 25 degrees F.
Loading—Desert	½-inch ice and 8-pound wind at 0 degrees F.
Weight	1,570 pounds per 1,000 feet.
Total length	1,640 miles.
Total weight	13,600,000 pounds.
Shipping lengths	1 mile (10 per cent—½ mile).

In the manufacture of the conductor the segments are drawn from flattened hot rolled copper rod through eight successive dies. (See Fig. 5.) The groove deepens and the tongue extends until section No. 8 is reached. Note the lower lip of the groove bent downward toward what will eventually be the inside of the cable. Also observe the neck of the tongue part.

In the closing machine ten of the final sections mentioned above are wound on bobbins in a little over one mile lengths. The bobbins are mounted in a rigid frame closing machine (by rigid is meant that the axis of the bobbin is fixed in, and in this case tangential to, the rim of the spider).

The segments, as the machine rotates, pay off through hardwood guides thence through a set of ball guides into the circular closing die which is the diameter of the finished cable. Here the segments are locked together by the action of a plug which rotates with the frame of the machine but which extends inside the converging segments as far as the die, with which it is concentric. This rotating plug closes the inside lip of the groove over the neck of the tongue and produces the completely interlocked conductor.

Joints and Dead-Ends

In conventionally stranded cables the inner elements are customarily gripped at the joint or dead-end by means of crushing or deformation of themselves and of the outer elements. The problem of jointing in type HH is particularly simple since all elements (segments) of this cable are readily accessible both externally and internally and over the greatest part of their peripheries.

Further the easiest shape to fit accurately with machined parts is a circular cross-section.

In the type HH joint a plug is inserted inside the conductor. Outside the conductor a conical split wedge is pulled down onto the conductor by an opposed wedge outside the inner wedge. Increasing tension in the conductor increases the grip in the joint. The dead-end is half a joint with an appropriate shank.

Vibration

The research work done in designing the Boulder dam-Los Angeles transmission line included some extensive work on the problem of conductor vibration which is the cause of so much worry to transmission line engineers all over the world.

If a uniform light breeze passes across a suspended conductor at approximately right angles to the line the conductor begins to vibrate vertically in wave lengths of from about ten to thirty feet depending on the wind velocity. The amplitude may be from infinitesimal to one or two inches, usually less than an inch. The wind velocities involved are from about 2 to 9 or 10 miles per hour. Above that value the characteristic wave length is so short that the energy necessary to maintain vibration becomes too great for the energy available from the wind, and vibration ceases. That at least is one of the theories of this vibration phenomenon.

The objection to the vibration is that its energy is dissipated mostly at suspension points which, being overworked, may fail under fatigue after a few months or few years service.

In line with their policy of caution the Los Angeles engineers have made a long research on vibration. Actual vibration in the field was studied by means of a double span erected on service towers at a location considered particularly liable to set up conductor vibration. An ingenious apparatus at the centre suspension point was developed by which a beam of light was projected through a pin point in a light metal diaphragm (the metal diaphragm being attached to the conductor or clamp, as the case might be, by piano wire) thence onto a travelling motion picture film. Simultaneously dots of light indicated time, wind velocity and wind direction.

Both conductor and suspension clamp motions were recorded simultaneously in order that relative motion between the two might be studied in the office. This relative motion represents the working on the cable tending to destroy it by fatigue.

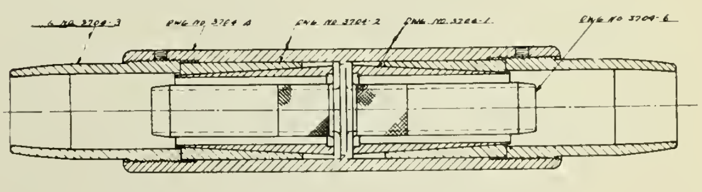
Fig. 6—Type of HH Joint.

This research indicated, up until about a year ago, that vibration occurred not over 3 per cent of the time during the worst season and during May, 1934, not over 1 per cent of the time. This is considered highly satisfactory.

Further, it was observed that no vibration occurred in winds above 6 miles per hour and the most at about 2 miles per hour. This means that the cable is such that it cannot follow the natural frequency due to the wind at the most dangerous velocities (i.e. when the energy content of the wind is high), and only vibrates when the wind energy available is so low as to greatly lower the possibility of damage.

At that time the maximum working angle between the cable and the clamps worked out to .0234 degree. In order to determine what this meant in reference to the ability of the cable to stand such working, the city engineer mechanically vibrated such a cable in a frame in their shops at over 15 times that value. The last report from this indicated that it had stood well over 500,000,000 cycles, without failure.

Additionally to these tests the city engineers studied the behaviour of clamps under vibrations mechanically imposed on the conductor.

At Leland Stanford, Dr. J. S. Carroll has been making extensive studies on vibration. In one study he electromagnetically vibrated various conductors at various wave lengths and various amplitudes, measuring the power input. Then in his unique wind tunnel he measured the frequency and amplitude at which various cables vibrated under various wind velocities. The wind tunnel is unique in that the wind blows across the long dimension instead of along that dimension. It was a big problem to get uniform wind velocities without pulsation or eddies perpendicularly to a fifty-foot sample.

Also at Leland Stanford, the P.G. & E. were studying vibration dampers, and at Los Angeles the Southern California Edison are erecting various types of cables on a tower line where particularly bad vibration trouble has been experienced in the past. The author understands that in Northern California the P.G. & E. are, or were, studying dampers on the line, an article having been published in "Electrical Engineering" during 1934 on their findings.

Altogether the State of California is very much alive to the vibration problem and there should be some valuable results available before long.

Present Status

The dam is complete, and the power house building practically complete. The first penstock will have been tested by the time this article is published.

The first two generators will be ready for operation June 1st, 1936, and two more by August 1st, 1936.

On November 1st, 1935, the water impounded was 4,013,000 acre feet, with a lake length of 80 miles. The inflow at that time was 5,270 second-feet with an outflow of 9,850 second-feet; i.e. the dam already is functioning to supply extra water during low stages of the river.

All the transmission line conductor has been shipped, the last shipment being made November 18th, 1935. All the desert single circuit tower transmission line has been completed and has passed, just recently, through a very severe wind storm. During this storm a number of transmission lines in the district, including an important 220-kv. line, were blown down. The Boulder dam-Los Angeles line described in this article was subjected, in the Cajon Pass section, to the highest recorded wind velocities in the district during the storm but a close and detailed examination showed no troubles.

The coastal district, 40 miles, has been held up until just recently due to right-of-way difficulties but these now are settled and the entire line will be finished by May 1st, 1936.

The author gratefully acknowledges information and illustrations received from Mr. W. O. Bolser, of the Department of Water and Power of Los Angeles, and Mr. D. M. Simmons, chief engineer of General Cable Corporation, manufacturers of the type HH transmission line conductor.

Geological Mapping With Aeroplane Assistance*

F. J. Alcock, Ph.D.,
Geological Survey of Canada, Ottawa, Ont.

Paper presented before the Ottawa Branch of The Engineering Institute of Canada, April 25th, 1935.

SUMMARY.—The author describes the advantages of employing aircraft in geological exploration in remote areas of the Precambrian shield. Accurate and complete topographic maps made from aerial photographic surveys are now available as a basis for geological work, many general features of which can also be obtained from the air. Aircraft facilitate ground exploration by transporting the bulk of a party's supplies, thus enabling the canoe parties to travel light and make their detail examinations with a minimum of physical effort.

During the field season of 1934 the author was engaged in mapping geologically a tract of country in northern Saskatchewan lying north of the Churchill river and drained by two of its tributary streams, the Mudjatik and the Haultain. The topographic mapping of the region by means of air photographs had brought out the possibility that the geology here might be worth investigating. Many of the lakes in the area are long and narrow and follow broad curves. Experience in other Precambrian fields suggested that this meant that the rocks in which the lake basins lie probably consisted of ancient sediments or volcanics intruded by oval-shaped masses of granite and that the drainage had adjusted itself to the softer formations surrounding the harder granite. Such an association of stocks of intrusive rock surrounded by older formations offers good prospecting territory. The region is also one of fairly easy access and it seemed desirable, therefore, to have it explored geologically since practically no information was as yet available concerning it. The provincial Department of Natural Resources offered, if the federal Geological Survey would undertake the investigation, to assist the party to and from the field, and to place at its disposal for the season a Vedette flying boat and a pilot.

When the author was asked to take charge of this exploration the proposal made a very strong appeal. Up to 1922 most of his work had been in northern Alberta, Saskatchewan and Manitoba in country very similar to this. Conditions of work, however, even as late as 1922, were entirely different from what this would be. In those days carrying out geological work in the western Precambrian meant not only studying the rock formations but it involved also making a topographic map to serve as a base to put the geology on for then the only maps available consisted of a few track surveys along the principal water routes. In more recent years our geologists in many areas have had the advantage of topographic surveys made from air photographs showing where the lakes and streams and muskegs lie thus enabling them not only to devote their main attention to their geology, but also to plan their work to much better advantage. Here in the Mudjatik region would be an opportunity not only to work with the new advantage of a good base map but to go one better and have in addition the use of a flying boat. It would be most interesting to see just how much help this would really be in saving time and labour and in doing more and better work.

The Mudjatik area may be reached by either of two routes both of which start from Prince Albert. The older is from end of steel at Big River and this still remains the one by which most of the freight is taken in. It follows along Cowan lake and Cowan river to Beaver river which empties into Ile-à-la-Crosse lake, an expansion of Churchill river. A new route has recently been opened up by way of Meadow Lake, about 125 miles northwest of Prince Albert where a clay belt has been developed into an important farming section. From Meadow Lake a truck road leads to Doré situated below what are known as the Grand Rapids of the Beaver and from there the Beaver offers a good water route to Ile-à-la-Crosse lake. Here is a trading post which has had a long interesting history for it lies on the old Methye portage route which for over one hundred years was the main highway to the Athabaska-MacKenzie region. Now in addition to the trading post there is a church, a hospital, a wireless station and district officer's quarters. At the north end of the lake where the Churchill makes a swing to the east is another post known as Wapache Wunak. The flying boat joined the party here and as the mouth of the Mudjatik is only about eight miles to the northeast, this post served as a convenient headquarters for provisions and gasoline.

The region to be investigated lies within the Canadian or Precambrian Shield and presents the features common over that vast region, the most striking of which is the multitude of lakes of all sizes and shapes which dot its surface. The relief varies from about 1,250 feet, the elevation of the Churchill river at the mouth of the Haultain, to around 1,850 feet the height of the higher ridge summits in the central part of the area. Rock ridges rise to heights of over 200 feet above the level of the adjacent lakes and most of the lakes have rocky shores. Being on a divide between three rivers, the streams of the area are all small, few of them large enough for travel even with light canoes. Hence in places to get from lake to lake long portages were

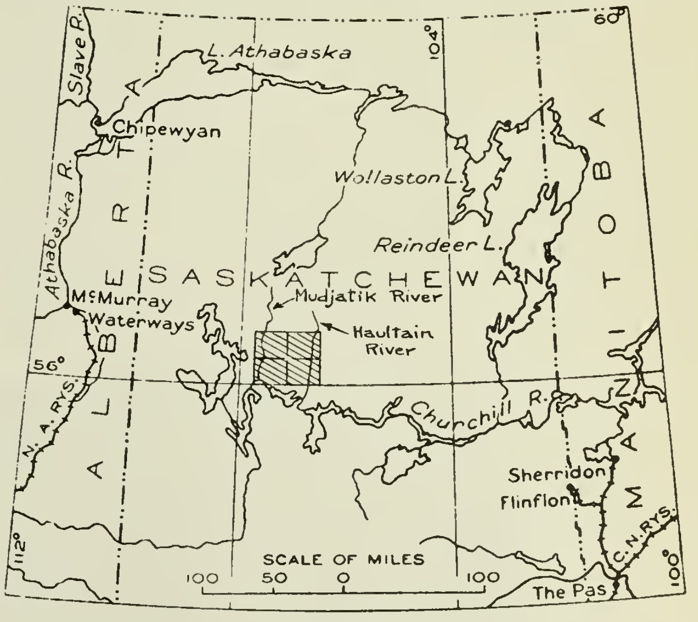

Fig. 1—Northern Saskatchewan. Hatched Section Indicates Area Surveyed.

necessary and the steep-sided character of many of the intervening ridges made the finding of feasible routes sometimes difficult. From the map a route of travel was planned through the area following the larger lakes so that from some places or other on it practically any point in the region could be reached. From camps conveniently spaced along this route the party proceeded by canoe in pairs to examine all the rock exposures along the lakes and to make

*Published with the permission of the Director of the Bureau of Economic Geology, Department of Mines.

inland traverses on foot at key places. Much of the country was covered by side trips lasting from two to four days away from the main camps made by members of the party travelling in pairs. With a light canoe and a silk tent it was often possible to travel without cutting trails and to make but one trip on the portages suffice.

With the assistance of the plane the amount of physical work necessary in travel of this kind was cut down to a minimum. Since regular trips were made by plane to Wapache Wunak for more gas and provisions it was never necessary to have more than ten days' supplies with us and when camp was to be moved loads were thus at a minimum. Before moving camp a preliminary flight was always made to choose the next camp site and to select the best route of travel for the canoes to follow along. In choosing a camp site first consideration had to be given the plane; there must be a sand beach or a muskeg shore where, when tied up, it would be safe no matter from what quarter a gale might blow. In moving, three flights of the Vedette usually took most of the load so that only one trip on the portage was all that was necessary for those travelling with the canoes. A most important feature which has already been referred to is that with the plane to do the portaging it was possible to travel with light canoes instead of with heavy freight ones, a vital consideration where portages are long and trails either poor or entirely lacking.

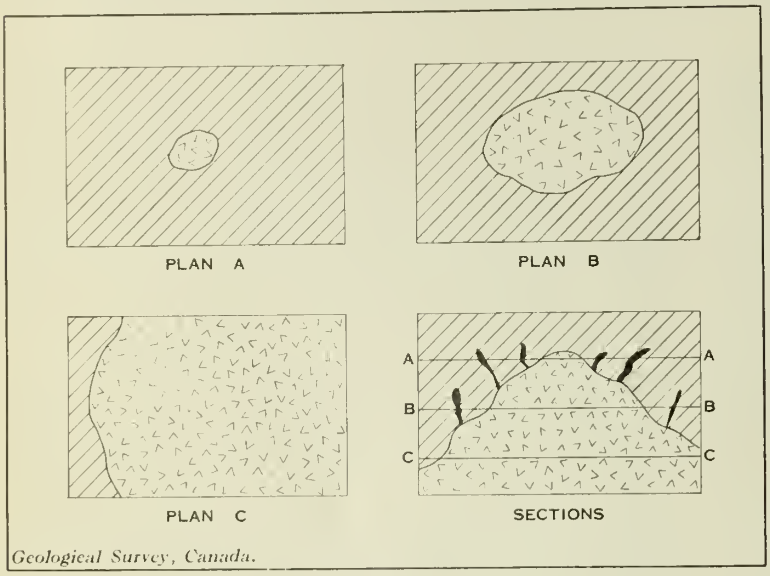

Fig. 2.

In addition to its labour-saving help the plane was of use in speeding up the actual geological mapping. Though the flying boat was unable to transport any of the ordinary canoes, the party was supplied with a collapsible canvas canoe which could be carried in the front cockpit. At times while members of the party were making traverses with the ordinary canoes, the pilot and the writer would fly to some lake, otherwise difficult of access, secure the plane fast in some bay, put the canoe together and spend the day examining the shore outcrops or in making traverses inland. In the evening a return would be made to camp. Some of the places which would have been the most difficult to reach by ground methods were thus reached and examined with a minimum of work and trouble.

Aside from these purely mechanical uses, it was interesting to see how much help could be obtained from the plane in connection with the more technical side of the work. It is the work of the geologist to study the various rock formations, to find out their relations, i.e., the sequence in which they were formed, and to indicate on a map their areal extent. If there are any known mineral occurrences it falls to his lot also to investigate these to try to find out why they are located where they are in order to direct intelligent search for more deposits. In the Mudjatik region there are a great many rock types but they all fall into three main groups. The first and oldest is a series of sediments originally laid down under water forming sandstones, shales, and locally limestone. Later a second group of dark rocks came up in a molten condition from deep within the earth's crust and injected themselves into the sediments for the most part along their bedding planes. All these rocks were later thrown into folds during mountain-building movements. Accompanying these movements great masses of granite arise from below in a molten state and intruded themselves into the overlying rocks. The granites carried mineralizing solutions which, during late stages of the cooling, were given off and resulted in the formation of ore deposits. A tremendously long period of erosion then followed during which the mountainous topography was reduced to one of low relief. This dissection brought to the surface the granites which had solidified at depths. in places denudation proceeded so far that only small remnants of the older formations were left. It is most important to have these areas of older rocks delimited for it is in the zones of contact between the older complex and the younger intrusive rocks that ore deposits may be expected to be found. The larger these areas of older rock the more hopeful are they as prospecting fields. Figure 1 is a diagrammatic representation of a region intruded by a large mass or batholith of granite. Plans A, B and C, represent geological maps of the region after it has been denuded to the respective levels shown in the section. It can readily be seen that at Stage A, the region is good prospecting country, that at Stage B, there is still hope of finding deposits, but that at Stage C, most of the ore deposits have been removed in the general dissection of the region. The geological mapping of the Mudjatik area brought out the fact that it is of the Stage C type, consisting of wide areas of granite or granite-gneiss with only narrow remnants of the older rocks remaining.

Much of the country had been swept by a series of forest fires and as a result there were large areas where from the air one could make a fairly good guess as to what

Fig. 3—Typical Topography of the Region.

rocks formed the ridges. For example, if we had paddled round a long narrow lake with continuous rocky shores and had seen nothing but granite-gneiss and, if on an adjacent lake nothing but that same rock type had been found, and further, if a flight over the intervening country showed bare hills of rock looking exactly like the exposures seen on the lake shores it was fairly safe to colour in the whole area without going to the trouble of making cross traverses on foot. In places where geological contacts on the ground had been located it was found possible to project these contacts by means of observation from the air. Even in burnt country, however, this had to be done with a great deal of caution while in country of green timber it was the author's experience that little reliance could be placed on guesses made from the air. Nevertheless air observation reduced to a minimum the amount of land traversing necessary and thus saved a great amount of time.

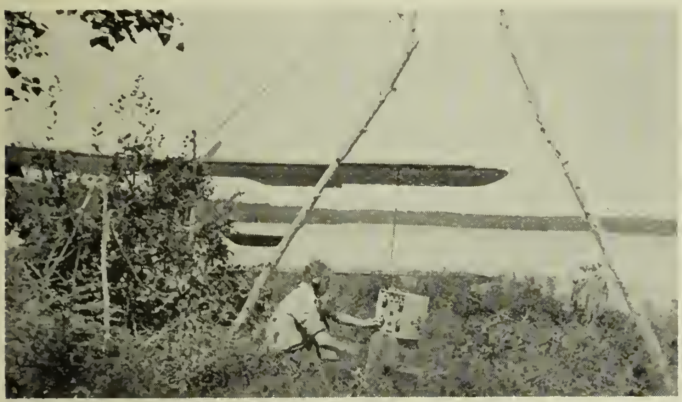

Fig. 4—Establishing Radio Communication with Ile-à-la-Crosse.

The only mineralization observed in the area were several large quartz veins and a few small sulphide showings none of which carried any appreciable gold content. Two of the quartz veins could readily be seen from the air. It is not the large veins of this type, however, which ordinarily prove of value and ground work must always be the method to locate the smaller gold-bearing veins. Sulphide deposits are commonly betrayed by their rusty gossan or iron-cap. In places these can be spotted from the air, but without careful ground work many more valuable ones might be readily passed up. Too much, therefore, must not be asked of the aeroplane.

It can be definitely stated, however, that aeroplane assistance has revolutionized geological mapping in the Precambrian fields of northern Canada. The difference between work with and without such assistance can only be fully appreciated by those who have worked under both sets of conditions. In a period of less than three months the author with aeroplane assistance mapped an area of some two thousand square miles. Modification of this work could be made to suit special undertakings. A plane capable of carrying canoes would be a still further improvement and help, and one such plane could service a number of geological parties working in the same general region. Geological supervision and co-ordination would also be possible by having an experienced geologist in charge of such a general undertaking. After the regional geological mapping was done in this way prospecting outfits could be placed in the likely areas delimited on the geological maps and these could similarly be serviced and supervised by aeroplane help. The possibilities of this new aid to geological investigation have only begun to be generally appreciated.

Annual General and General Professional Meeting

HAMILTON, ONTARIO

FEBRUARY 6th and 7th, 1936

***Headquarters*—Royal Connaught Hotel**

Business Meeting **Annual Dinner** **Reception and Dance**

Technical Sessions and Plant Visits

Entrance to Hamilton Harbour.

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VOLUME XVIII DECEMBER 1935 No. 12

The Fiftieth Annual General Meeting

Notice is hereby given that in accordance with the By-laws, the Annual General Meeting of The Engineering Institute of Canada for 1936 will begin at Headquarters at eight o'clock p.m., on Thursday, January 23rd, 1936, for the transaction of the prescribed business, and will be adjourned to reconvene at the Royal Connaught Hotel, Hamilton, at ten o'clock a.m. on Thursday, February 6th, 1936.

The Quebec Electricity Commission

An important commission has been constituted under recent legislation in the province of Quebec, for the purpose of regulating public services in connection with the production, transmission and distribution of electricity in the province. Dr. Augustin Frigon, M.E.I.C., now Director of Technical Education of the province and Dean of the Ecole Polytechnique, Montreal, has been named chairman of the new Quebec Electricity Commission; Dr. O. O. Lefebvre, M.E.I.C., at present chief engineer of the Quebec Streams Commission, has been appointed vice-chairman, and J. W. McCammon, A.M.E.I.C., consulting engineer of Montreal, becomes a commissioner.

The powers of the new commission are very wide, and the future of the electrical power industry in the province of Quebec will be largely dependent upon its policies and activities. The provincial government is, therefore, to be congratulated on securing for the personnel of the commission three engineers of such standing and experience. The duties of the commissioners will involve technical knowledge and judgment of a high order, and it is refreshing to find that this fact has been realized by the government and that a departure has been made from the customary practice of selecting commissioners almost exclusively from men having a legal or business training. It is probable that the secretary of the commission, yet to be appointed, will be a lawyer, so that expert opinion will be available on the legal aspect of the commission's work.

The commission has power, generally, to hold enquiries into the electricity services in the province, particularly as regards quality of service, equipment, means of protection, extension of the systems, reports to be made, rules, regulations, conditions, and practices affecting the rates and charges connected therewith. It will be the judge in cases of dispute between a company and a municipality as to the right to use a street or water-course, and other similar questions. Its approval must be given to the construction or operation of any new line or plant, and the same control will apply to extensions or alterations to a plant. Whenever the public interest demands, the commission may order any public service to extend its line, network or system. No public service may wholly or partly suspend operations without its approval.

Schedules of all rates must be filed with the commission, and no increases or alterations in classification or rules will be permitted without showing justification to the commission, and getting its approval. All rates and charges claimed by a public service must be established in the interest of the consumer, and in that of the public service and of the investors therein, and must be fixed with due regard for the economic interests of the province and the particular conditions of the service concerned, so as to assure a just and reasonable revenue for such public service; taking into account, however, only expenses really and justly applicable to the operation of the public service in question.

The commission may set rates upon its own motion, as well as upon complaint. The commission may also disapprove or vary the terms of a contract hitherto existing, when it is a matter of distribution or sale of electricity for light, heat, energy or motive power.

Sales of one company to another or mergers of companies are subject to commission approval, and approval is required also for exchange of services. All capitalization of a public service is under the supervision of the commission, and uniform bookkeeping systems may be required. Contracts between a municipality and a public service also require ratification.

Guarantees of the impartiality and independence of the commission are provided, since no commissioner may hold any office or carry on any employment inconsistent with the performance of his duties, nor may he hold or be interested in any security of any public service corporation. The commissioners will give their attention exclusively to the work of the commission and must not follow any other occupation. They will be independent of the government and of political influence, since it is provided that they shall remain in office during good conduct, and may be dismissed only by the Lieutenant-Governor on a joint address of the Legislative Council and Legislative Assembly. Employees for the commission's service will be appointed by the Lieutenant-Governor-in-Council, and provision has been made for pensions for the commissioners on the same basis as for provincial judges.

The Nickel Industry

It is nearly fifty years since nickel was found to occur in the copper-bearing ores of the Sudbury mining district. In addition to copper, that area is now yielding gold, silver, selenium, tellurium, and metals of the platinum group, and, most important of all, is providing some eighty per cent of the world's requirements of nickel, the Canadian production of that metal in 1934 amounting to about 64,000 tons. An industry yielding over thirty million dollars a year is one in which Canadians certainly should be interested, particularly since its principal product has now become an essential in so many branches of engineering work.

The remarkable increase in nickel production which occurred in 1933 and 1934 was largely due to general improvement in industrial activity, but was greatly hastened by extensive researches carried out by the producing companies in order to discover and encourage new peace time uses for the metal. A useful resumé of the progress made in the metallurgy of nickel during the past ten years was given at the recent International Congress of Mines, Metallurgy and Applied Geology in Paris by Vice-President J. F. Thompson, of the International Nickel Company of Canada. Incidentally his statements will do much to correct the common idea that nickel is almost entirely used for military purposes. Striking figures were given by Dr. Thompson as to the great variety of commercial uses to which nickel is now applied.

Those who remember Sudbury in the days when the ore was roasted out of doors in great heaps, with wood as fuel, will learn with interest of the revolutionary changes that have been introduced in the treatment of the ore, particularly as regards the recovery of the platinum values from the ore of the Frood mine, and the production of metallic nickel of the extremely high purity now required, over 99.9 per cent. Much of the refined nickel used in Canada and the United States is now produced electrolytically at Port Colborne from the Sudbury matte, while metal of specially high purity is also made by the nickel-carbonyl process at Clydach in South Wales.

In his address Dr. Thompson drew attention to the

Fiftieth Annual Meeting

Members who recall the very successful meeting held in Hamilton seven years ago will be pleased to hear that the Annual Meeting Committee of that Branch, under the chairmanship of Mr. W. Hollingworth, M.E.I.C., are now completing their preparations for the welcome of members who will attend the Fiftieth Annual General and General Professional Meeting of The Institute to be held at the Royal Connaught Hotel, Hamilton, on Thursday and Friday, February 6th and 7th, 1936.

The city of Hamilton offers many advantages as a location for a gathering of this kind, not the least being easy access for the large Institute membership in the industrial area of Ontario in which it is so centrally situated. For those coming by train the railways will offer low rates for parties to be organized by our branch secretaries.

The following is an outline of the programme:

Thursday, February 6th:—

Morning:	Registration and Business Session.
	Induction of Incoming President and Council.
Noon:	Formal Luncheon.
Afternoon:	Technical Sessions.
	Reception and Tea for Ladies.
Evening:	Annual Dinner of The Institute.—Speaker, Sir E. W. Beatty.
	Dance.

Friday, February 7th:—

Morning:	Technical Sessions.
Noon:	Luncheon.
Afternoon:	Technical Sessions.
	Visits to Plants.
Evening:	Smoking Concert.

An attractive series of social events will be arranged, while as regards the technical features of the meeting, there will be a series of papers on transportation topics, featuring the effect of recent development of the various phases of that industry, especially with reference to the parts which different agencies of transportation can take in Canada's transport system. This timely presentation is expected to give rise to active discussion.

In addition, several papers will be presented on topics illustrative of some of Hamilton's manufacturing industries. These will be of particular interest in connection with electrical and ceramic work. Structural engineers will note an important paper on bridge construction.

The meeting will conclude with visits to a number of the varied engineering and industrial plants of which Hamilton possesses so many.

City of Hamilton from the Mountain

fact that over seventy per cent of the world consumption of nickel is used for alloys, and new uses for these alloys are being continually developed. For example, of the seventy-nine alloy steels in use in the automobile industry in North America, forty-one contain nickel, and that industry absorbs about twenty per cent of the world's production of the metal. There has been a corresponding increase in the use of alloy steels outside the automotive industry, due in large measure to advances in the technique of making these nickel-ferrous alloys. The old idea that alloy steels are useful only in the quenched and tempered condition is now quite discredited, as so many of them are giving excellent service in the "as rolled" condition, or after simple normalizing treatment. Certain nickel alloy steels have the remarkable property of retaining toughness at extremely low temperatures, and are finding employment for pressure vessels used at temperatures down to −75 degrees F., while others have been developed for use at high pressures and temperatures up to 1,500 degrees F., as in cracking stills and modern high pressure steam boilers.

Many troublesome technical problems have been solved by recent research in the metallurgy of nickel. Thus, the prevention of corrosion in condenser tubes by the use of a suitable copper-nickel alloy; the use of nickel-clad plates for tanks and containing vessels in the heavy chemical industries; the development of bright nickel plating requiring no buffing; the widening of the field of use of the stainless steels, are all achievements of which the industry may be proud. A multitude of new products have been placed at the disposal of the engineer, such as nickel-iron alloys which have special magnetic qualities, and age-hardening bronzes containing nickel and possessing remarkable properties as regards strength, hardness and ductility. All these are milestones on the road towards the era of alloys, and are results of the combined researches of the producers and the various consumer groups in the nickel industry.

Talking with Swiss Engineers

Canadian engineers in Montreal had an opportunity on the afternoon of November 22nd, 1935, of greeting their colleagues in Switzerland by speaking by trans-Atlantic telephone with a meeting of members of the Technical Society of Winterthur in Switzerland.

At the Winterthur meeting an evening lecture was being given by Professor Dr. Von Salis, on the subject of trans-oceanic telephone service, and by way of practical demonstration of his remarks, the brief addresses of the Montrealers were transmitted direct by wire and wireless telephony and received at the meeting over a loud speaker public address system installed in the lecture room.

The General Secretary of The Engineering Institute introduced the speakers to their Swiss audience, and with him in the board room of the Bell Telephone Company were Dr. F. A. Gaby, M.E.I.C., President of The Institute, Paul Ackerman, A.M.E.I.C., consulting engineer of the Shawinigan Power Company, and former student at the Federal Polytechnikum at Zurich, and Gaston Jaccard, Swiss consul-general, each of whom spoke in turn.

Dr. Gaby presented greetings from The Engineering Institute, and recalled incidents of two visits he had made to Switzerland some years ago, and M. Jaccard gave a brief resumé of conditions in Canada, both industrial and commercial. Mr. Ackerman gave a similar talk stressing recent engineering activities and achievements in Canada. The two latter gentlemen spoke in German.

Mr. M. Du Bois, Jr.E.I.C., assistant to the director of Sulzer Bros. Limited, Winterthur, and formerly a resident of Montreal, acknowledged and reciprocated the greetings of the Canadian engineers. The reception was excellent at both ends.

Mr. C. F. Sise, President of the Bell Telephone Company of Canada, a group of telephone officials and newspapermen listened to the two-way conversations through instruments installed for the occasion. The arrangements which made this telephone conversation possible in Canada were in the hands of the Bell Telephone Company of Canada, Limited. Facilities at the European end were given through the co-operation of the British Post Office and the Swiss Telephone Administration.

Committee on Consolidation

The Committee held its eighth meeting at The Engineering Institute Headquarters on Wednesday, November 6th, 1935, at 8 p.m. At this meeting the Chairman made a review of the activity which had taken place in the various Branches of The Institute and in the Professional Associations, with reference to the consideration of Consolidation, during the summer months.

This Report indicated that this important matter was being seriously considered throughout Canada, and that active discussions were being carried on among the general membership which had been productive of many constructive suggestions, and much general interest in the possibilities of the organization and development of the profession.

The returns on the "Questionnaire" issued by the Committee were received and analyzed, and indicated the following approximate figures:—

Possible Replies.	
Engineering Institute	2,630
Professional Associations	3,807
Total	6,437
Replies.	
Number of members represented by replies	4,262
Question No. 1—Yes, 4,234; No, 28.	
Question No. 2—Yes, 3,841; No, 353.	
Question No. 3—Yes, 3,900; No, 343.	
Question No. 4—Yes, 4,147; No, 33.	
Question No. 5—Yes, 3,953; No, 87.	

Membership of Branches of Institute and Provincial Associations not represented in the replies:

St. Maurice Valley Branch	27
Lethbridge Branch	24
Professional Association of Alberta	253
Vancouver Branch	127
Professional Association of British Columbia	808
	1,239

At its meeting of November 2nd, the Council of the Association of Professional Engineers of Alberta decided to continue its endeavours for co-ordination through the Dominion Council, and in this it is following the same policy as the Professional Association of British Columbia.

The Committee on Consolidation suggested to the Council of The Institute the advisability of issuing an invitation to all the Provincial Professional Associations through the Secretary of the Committee of Eight, to hold a meeting of that Committee in Hamilton, on the occasion of the Annual Meeting of The Institute in February, 1936. Council has issued this invitation.

All the suggestions relative to Consolidation which have been received by the Committee as a result of the "Questionnaire" or otherwise, are now being studied by the Committee, with a view to placing its report and recommendations before the Council of The Institute at its meeting of December 20th, 1935.

Gordon McL. Pitts, A.M.E.I.C.,
Chairman
Committee on Consolidation.

OBITUARY

John Simeon Armstrong, M.E.I.C.

John Simeon Armstrong, M.E.I.C., whose death occurred at Fredericton, N.B., on July 4th, 1935, was a member of many years standing, having joined the Canadian Society of Civil Engineers at its formation in January 1887.

A graduate of King's College, Windsor, N.S., of the year 1869, Mr. Armstrong was awarded the General Williams prize in engineering. His early work was in connection with railway construction on the Intercolonial Railway in 1870, and the following year he was engaged on the Bay Verte canal project. Subsequently Mr. Armstrong was assistant engineer with the Department of Public Works in charge of a party on the Saint John, N.B., harbour survey. His later appointments included the following: assistant engineer, locating and on construction of the Salisbury and Hillsboro Railway; leveler on Aulac and Cape Tormentine Railway survey; general survey and plan for Halifax sewerage; engineer for gold prospecting and mining in Nova Scotia; member of contracting firm engaged for five years in building construction in Saint John, N.B.; construction engineer and general manager, Lincoln Pulp and Paper Company at Lincoln, Maine; preliminary and location surveys for the Temiscouata Railway in Quebec and New Brunswick and charge of preliminary survey and construction of a section of the Edmundston and St. Francis branch of that railway; principal assistant engineer with the Chignecto Marine Transport Railway between the years 1888 and 1891; engineer and general manager, Chambersburg and Gettysburg Railway in Pennsylvania; manager of the Caledonia Mining and Manufacturing Company at Graffenburg, Pa.; chief engineer on preliminary and locating surveys for the Canso and Louisburg Railway in Cape Breton; bridge engineer and principal assistant on Midland Railway in Nova Scotia and later contractor's engineer for the Shubenacadie bridge.

In addition to the above, Mr. Armstrong was for a period engaged in private practice as patent attorney on the United States government register and was later engineer and secretary treasurer of the Coal Mining Company in the Grand Lake Coal district of New Brunswick. He was actively engaged in the Good Roads movement in New Brunswick particularly in connection with the formation of the Saint John City and County Goods Roads Association and the New Brunswick Good Roads Association. In 1926 Mr. Armstrong entered private practice as consulting engineer, specializing in harbours, canals, railways, transport, patents and special submarine works.

Mr. Armstrong joined the Canadian Society of Civil Engineers as a Member on January 20th, 1887.

PERSONALS

J. L. Balleny, A.M.E.I.C., has joined the staff of the Canadian General Electric Company Limited at Toronto, Ont. Following graduation from McGill University in 1925 with the degree of B.Sc., Mr. Balleny joined the staff of the company which he now rejoins, being engaged on general machine testing in the test department. In 1926 and 1927 he was in the industrial control engineering department on the design of miscellaneous equipment, and in 1927 he was appointed industrial electric heating engineer in charge of design, construction and the installation of all types of electric heating equipment, which position he held until 1929 when he became attached to the mechanical engineering department of the Dominion Bridge Company Ltd., Montreal. In 1932 Mr. Balleny was with the Beauharnois Light Heat and Power Company, at Beauharnois, Que.

THE QUEBEC ELECTRICITY COMMISSION

Dr. Augustin Frigon, M.E.I.C., who has been appointed the chairman of the new Quebec Electricity Commission, is a prominent French-Canadian electrical engineer, and a graduate of the Ecole Polytechnique, Montreal, of which he is now the Dean. Following graduation he studied at the Massachusetts Institute of Technology, Boston, and then travelled abroad. In Paris he took courses at the Ecole Supérieure d'Electricité and received the degree of Doctor

Dr. A. Frigon, M.E.I.C.

Dr. O. Lefebvre, M.E.I.C.

of Science from the University of Paris. Dr. Frigon is at present chairman of the Montreal Electrical Service Commission, and served on the Royal Commission appointed in 1928 to investigate radio broadcasting. He is a member of the National Research Council, Ottawa. His experience in the electric power industry in Quebec has been extensive and varied, largely in connection with the work of the Quebec Public Utilities Commission. He takes an active interest in Institute affairs and is a member of Council and a past-chairman of the Montreal Branch.

Dr. Olivier Lefebvre, M.E.I.C., a past-president of The Institute, vice-chairman of the new commission, graduated from the Ecole Polytechnique, with honours, in 1902. After some three years in the laboratories of the Department of Public Works in Ottawa, he became assistant to the Ottawa district engineer, and was engaged in river surveys and the construction of wharves, dams and other works carried out by the Department in that locality. In 1912 he was sent to Vancouver to make a complete survey of Burrard Inlet and False Creek. In 1913, leaving the Dominion Service, Dr. Lefebvre entered that of the province of Quebec as chief engineer of the Quebec Streams Commission, and since that time has been responsible for practically all of the important projects initiated by the Streams Commission to provide effective government regulation of the flow of the great rivers of the province whose power is being developed under private ownership. Dr. Lefebvre is a member of Council of The Institute, a Member of the American Society of Civil Engineers, and serves on the Administrative Board of the Ecole Polytechnique, Montreal. In 1929 he received the Honorary Degree of Doctor of Science from the University of Montreal.

J. W. McCammon, A.M.E.I.C., graduated from McGill University in 1912 with the degree of B.Sc., and later took an apprentice course with the Canadian Westinghouse Company at Hamilton, Ont. Following this he was for a time assistant to the mechanical and electrical engineer of Mackenzie Mann and Company on the Mount Royal Tunnel, Montreal, and was later for nine years manager of the pump and electrical departments of Canadian Fairbanks Morse Company, Montreal. He was connected with Charles Walmsley Company, Montreal. From 1929 to 1934 Mr. McCammon was assistant to the general manager of the Beauharnois Light, Heat and Power Company. Mr. McCammon served overseas during the War, having enlisted in 1915 with the 6th Siege Battery. He received

J. W. McCammon, A.M.E.I.C.

a commission in the Royal Garrison Artillery in 1917, was transferred to the Canadian Garrison Artillery with the rank of lieutenant in 1918, and demobilized in 1919. Mr. McCammon has been an Associate Member of The Institute since 1924.

A. T. Perrin, M.E.I.C., formerly chief engineer of the Whiting Corporation (Canada) Limited, Toronto, has been appointed general superintendent of Sawyer Massey Limited at Hamilton, Ont. Mr. Perrin was at one time with E. A. Turner and Company, Toronto, and prior to that was with the mechanical department of the Dominion Bridge Company at Lachine Que.

Lieut.-Colonel A. E. Dubuc, D.S.O. and Bar, Chevalier de la Légion d'Honneur, M.E.I.C., chief engineer of the Department of Railways and Canals, Ottawa, has been made a member of the board recently appointed to deal with the ports of the Dominion.

Colonel Dubuc graduated from Laval University in 1901 with the degree of B.A.Sc., and following graduation became an assistant engineer with the Department of Public Works, Canada, at Ottawa. In 1912 he was appointed district engineer for the Department at Montreal.

In October 1914 Colonel Dubuc enlisted for service overseas with the 22nd French-Canadian Regiment, being promoted to the rank of Captain in the same year. In 1915 he became a Major, and in 1916 acting Lieutenant-Colonel, commanding the Regiment in the actions of

Lieut.-Colonel A. E. Dubuc, M.E.I.C.

Regina Trench in 1916, at Vimy Ridge in 1917, and at Neuville-Vitosse, Mercatel, Amiens, Arras and Chérisy in 1918. Colonel Dubuc was wounded at Kemmel in 1915, at Yprès in 1916 and at Chérisy in 1918. In 1918 he became Lieutenant-Colonel. Colonel Dubuc received the Distinguished Service Order and was made a Chevalier de la Légion d'Honneur in 1917, and in 1918 received a Bar to his D.S.O. and was twice mentioned in despatches. In December 1920 he was promoted to the rank of Colonel and given command of the 11th Infantry Brigade.

Returning to Canada in 1919 Colonel Dubuc was appointed superintending engineer of the Department of Railways and Canals, and in 1924 became chief engineer of the Department.

ELECTIONS AND TRANSFERS

At the meeting of Council held on November 12th, 1935, the following elections and transfers were effected:

Member

ANDERSON, Hope Vere, (Glasgow and West of Scot. Tech. College), senior asst. engr., Dept. of Marine, Ottawa, Ont.

REID, Charles Roy, B.Sc., E.E., (Univ. of Oregon.), M.M.E., (Cornell Univ.), asst. gen. supt., Shawinigan Water and Power Co., Montreal, Que.

Associate Member

FRY, Edmund Botterell, B.Sc., (McGill Univ.), engr. and surveyor, Howey Gold Mines Ltd., Red Lake, Ont.

Juniors

FRASER, Innes Martell, B.Sc., (N.S. Tech. Coll.), potentiometer mtce. man., Imperoyal, Dartmouth, N.S.

KATZ, Leon, B.Sc., (Queen's Univ.), foreman, Monarch Battery Mfg. Co. Ltd., Kingston, Ont.

McGUIRE, James Francis, B.Eng., (McGill Univ.), apprentice, Montreal Armature Works Ltd., Montreal, Que.

Affiliate

WEBSTER, Frederick Henry Thomas, chief engr., Homoeopathic Hospital, Montreal, Que.

Transferred from the class of Associate Member to that of Member

GAUTHIER, Paul Gilles, B.Sc., (McGill Univ.), Civil Engineer and Quebec Land Surveyor, 660 de L'Epee Ave., Outremont, Que.

Transferred from the class of Junior to that of Associate Member

BENJAMIN, Abraham, B.Sc., (McGill Univ.), elect'l. designer, Montreal Light, Heat and Power Cons., Montreal, Que.
BOWN, Charles Roy, B.Sc., (McGill Univ.), asst. chief engr., Canada and Dominion Sugar Co. Ltd., Montreal, Que.
HARRIS, Arthur Clifford, B.Sc., (N.S. Tech. Coll.), asst. engr., City of Halifax, N.S.
HOLDEN, John Hastie, B.Sc., (McGill Univ.), sales mgr., Geo. W. Reed & Co. Ltd., Montreal, Que.
McBRIDE, Ernest Willard, B.A.Sc., (Univ. of Toronto), technical engr., Abitibi Power and Paper Co., Toronto, Ont.
WILSON, Archdale McDonald, B.Sc., (Queen's Univ.), asst. engr., Algoma Central and Hudson's Bay Rly., Sault Ste. Marie, Ont.

Transferred from the class of Student to that of Associate Member

BENNETT, Arthur J., B.Sc., (McGill Univ.), sales engr., English Electric Co. of Canada Ltd., Montreal, Que.
CUNNINGHAM, George Allin, B.A.Sc., (Univ. of Toronto), district representative, Imperial Oil Ltd., Peterborough, Ont.
DOBRIDGE, Ronald Wemyss, B.Sc., M.Sc., (McGill Univ.), transformer engr., Canadian Marconi Co., Montreal, Que.
HAMILTON, Robert William, B.Sc., (McGill Univ.), elect'l. engr., Dominion Electric Protection Company, Montreal, Que.

Transferred from the class of Student to that of Junior

BARBOUR, Clarence Allen, B.Sc., (Univ. of N.B.), prop., Maritime Radio and Electrical Supplies, Saint John, N.B.
HART, William O., B.Sc., (Queen's Univ.), sales and advertising mgr., Oshawa Dairy Ltd., Oshawa, Ont.
HUTTON, John R., B.Sc., (N.S. Tech. Coll.), engr., lamp dept., Canadian Westinghouse Co. Ltd., Hamilton, Ont.

Students Admitted

BEAULIEU, Gerard, (Ecole Polytech., Montreal), 3636 Henri Julien St., Montreal, Que.
ELMSLEY, Clarence Mathieu Remy, (Queen's Univ.), 30 Sydenham St., Kingston, Ont.
FIELD, George Lewis, instr'man., Beauharnois Light, Heat and Power Co., Montreal, Que.
GARDEN, Joseph MacKenzie, (McGill Univ.), 3420 Hutchison St., Montreal, Que.
LEY, Cecil John, junior dftsman., Dominion Bridge Co. Ltd., Lachine, Que.
McGREGOR, Leslie Stewart, (McGill Univ.), 5940 Clanranald Ave., Montreal, Que.
MOULE, Gerald William, (Univ. of Man.), 79 Balmoral Place, Winnipeg, Man.
RICE, Joseph Donald, B.Eng., (McGill Univ.), 2044 Victoria St., Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Society of Civil Engineers: Transactions 1935.
North East Coast Institution of Engineers and Ship Builders: Transactions vol. 51, 1934-35.
Highways Research Board: Proceedings of the 14th Annual Meeting, 1934.
American Society of Mechanical Engineers: Transactions of the Hydraulic Institute of the Munich Technical University, 1935.

Reports, etc.

Report of the Lieutenant-Governor's Committee on Housing Conditions in Toronto, 1934.
Federal Housing Administration, Technical Division: Recent Developments in Dwelling Construction.
Province of Quebec Association of Architects: Charter, By-laws and Code of Ethics, 1935.
Ontario Department of Mines: 44th Annual Report, 1935.
National Research Council: Evaporation from Gasoline Storage Tanks under the Influence of the Sun's Radiation, by R. Ruedy.
Canada, Dept. of Marine: 68th Annual Report, 1934-35.
Canada, Dept. of Mines: Report for year ending March 31st, 1935.
Canada, Dept. of Marine, Hydrographic Service:
Tide Tables for the Pacific Coast of Canada for 1936.
Tide Tables for the Atlantic Coast of Canada for 1936.
University of London: Calendar for the year 1935-36.
Smithsonian Institution: Annual report 1934.
Quebec Streams Commission: 23rd Report, 1934.
Canada, Dept. of Mines, Mines Branch: Gasoline Survey for 1934.
Institution of Civil Engineers: Selected Engineering Papers:
No. 172: Construction of the New Sea Locks of the Crinan Canal.
No. 173: Depreciation of Plant and Machinery.
No. 174: Photo-elastic Investigations of Shear Tests of Timber.
No. 175: Manœuvring of Single-Screw Ships: The Effect of Rudder Proportions on Manœuvring and Propulsive Efficiency.
No. 176: The Bridges of the Egyptian State Railways.
No. 177: The Survey and Reconstruction of the Lyme Regis Sea Defences.
No. 178: The Theory and Design of Propeller-Type Fans.
No. 179: Catenarian Functions.
No. 180: Caisson Sinking at Plantation Quay, Glasgow.
Vernon-Harcourt Lecture 1933-34.
Canals and Canalized Rivers.
Special Lectures:
The Construction of two New Canals for Inland Navigation in the Netherlands.
Military Bridging.
Hydro-Electric Power Development on the Rhine.
Institution Lecture to Students:
Modern Methods and Plant for Excavations.

Technical Books, etc. Received

Mineral Deposits, by W. Lindgren. (*McGraw-Hill Book Co., New York.*)
Heat Engines, by Moorfield and Winstanley. (*Edward Arnold & Co.*) (*Longman's Green & Co., Toronto.*)

BULLETINS

Belt Conveyors—The Jeffrey Manufacturing Company, Columbus, Ohio, have issued catalogue No. 610, containing 112 pages, and giving full particulars regarding belt conveyors and accessories manufactured by the company. Standard sizes range from 14 to 60 inches. The catalogue includes pertinent data and illustrations of typical installations.

Conveyors—A 16-page bulletin received from the Jeffrey Manufacturing Company contains particulars and illustrations of the methods used in excavation and handling of material in the building of the Grand Coulee dam.

Sheet Piling—A 12-page booklet issued by the Canadian Sheet Piling Company, Montreal, contains particulars of a number of installations of Larssen steel sheet piling.

Portable Air Compressors—Canadian Ingersoll-Rand Company Ltd., Montreal have issued a 24-page booklet containing data on the company's complete line of 2-stage air-cooled gasoline and oil engine driven portable air compressors.

Precision Lathe—A catalogue issued by the South Bend Lathe Works, South Bend, Indiana, describes the new 9-inch "workshop" precision lathe. The booklet contains a number of illustrations, describing the 8 different models of this lathe, and giving instructions for performing the many operations encountered in the machine shop, and displaying the complete set of attachments this lathe can be fitted with.

BOOK REVIEWS

Elements of Machine Design

By D. S. Kimball and John H. Barr. John Wiley and Sons (Renouf Publishing Company, Montreal), New York, 1935. Third and revised edition. 6 by 9¼ inches. Diagrams. 469 pages. Cloth, $4.00.

Reviewed by Professor N. M. Hall, m.e.i.c.*

The large number of mechanical engineers who are familiar with the 1909 and 1923 editions of this book will welcome the appearance of the new 1935 edition by the same authors, Dean Dexter S. Kimball of Cornell University and John H. Barr, formerly professor of machine design at the same institution.

It retains the same general form, adequately illustrated by diagrams of fundamental designs but unencumbered with photographs of machines, tables and catalogue matter which are subject to frequent change, and which are readily available from handbooks, catalogues and technical data issued from time to time by manufacturers.

While the book presupposes a knowledge of mechanics of machines, this subject is adequately reviewed in the opening chapters, and the remainder is devoted to the fundamentals which form the basis of machine design. At the end of each chapter will be found a useful list of references to books, transactions of national societies and manufacturers' data, from which further study of the subject matter of each chapter can be pursued.

Obsolete matter of the earlier editions has been eliminated, and considerable new material covering the advances in research and design have been inserted. This, for example, includes the recent work in lubrication and bearing design.

While written primarily for use as a college text book, it will prove useful to the designer who may wish from time to time to review the fundamentals of machine design and bring himself up to date on the recent advances in the subject.

The book has been enlarged to 469 pages and is adequately illustrated.

*Professor of Mechanical Engineering, University of Manitoba, Winnipeg, Man.

Industrial Electronics

By F. H. Gulliksen and E. H. Vedder. John Wiley and Sons, New York. (Renouf Publishing Company, Montreal). 6 by 9¼ inches. 245 pages. Cloth. $3.50.

Reviewed by G. A. Wallace, A.M.E.I.C.*

This book is a very business-like treatment of the application of electronic tubes in fields other than communication engineering and sound reproduction, and it will be greatly appreciated by those who are actively engaged in making such applications.

There is no excess verbiage in this book. From the first page to the last the authors have attended strictly to business and their working principle has apparently been to cram the maximum amount of information into the minimum amount of space. The result is a book which may seem a little dry to the casual reader, but which is full of interest to the practical worker.

The book is well arranged. The authors begin by devoting twenty-nine pages to a very concise classification and description of electronic tubes and their characteristics. This is followed by a thirty-page classification and description of the various methods of controlling these tubes. Then come the practical applications. These practical applications are very diverse, but the preliminary classification and treatment of the control methods serves to bring order and system into what might otherwise appear to be an uncorrelated jumble of miscellaneous devices.

The applications covered include photo-electric relays, elevator floor levelling, automatic control of lighting, sorting, grading, matching and counting by means of photo-electric cells, telemetering, smoke indicators, stroboscopes, rectifiers, inverters, welding, theatre dimming, oil-burner control, automatic train control, precipitation, X-ray equipment, automatic synchronizers, time delay relays, cycle splitters, protective relays for power systems, automatic regulators of voltage, speed, frequency, and temperature, register regulators for printing and cutting-off machines, tension regulators, colorimetric regulators, etc.

The numerous wiring diagrams are quite complete but the values of resistance, inductance and capacitance are not given; consequently the reader cannot duplicate these circuits, or apply them directly without doing a certain amount of design or experimental work. In other words the authors give the fundamental ideas and the circuit schemes that have proved effective, and leave the reader to work out the specific details to suit his own particular case. This is probably as far as any writer would care to go while the art is changing as rapidly as it is at present.

The bibliography at the end of each chapter is a valuable part of the book. A total of one hundred and twenty-nine references are given.

*Associate Professor of Electrical Engineering, McGill University, Montreal.

Well-known Toronto Engineer Dies

William Inglis, president and general manager of the John Inglis Company Ltd., Toronto, Ontario, who died recently was an affiliate of the Toronto Branch of The Institute.

Mr. Inglis was born at Guelph, Ontario, on October 20th, 1867, and in 1880 entered his father's business, Inglis and Hunt, as an apprentice. In 1881 the plant was moved from Guelph to Toronto, and in 1890 Mr. Inglis was admitted to the firm as a partner, the name being changed to John Inglis & Son. After the death of John Inglis in about 1895, Mr. William Inglis became the directing head of the company, and when the firm was incorporated in 1903 as the John Inglis Company, Limited, he became President. Mr. Inglis was also head of the S. Morgan-Smith-Inglis Co. Limited, Toronto, and of Webster-Inglis Limited, Toronto, and was a director of Dufferin Paving and Crushed Stone Limited, Toronto. In 1933 and 1934 Mr. Inglis was president of the Canadian National Exhibition, and had been a director for many years. He was known throughout Canada as a skilled expert in steel-plate construction, and was one of the original Canadian manufacturers of boilers, tanks, marine buoys and similar plate work.

Mr. Inglis had been chairman of the Ontario Branch of the Canadian Manufacturers' Association and always took a leading part in the affairs of that organization and of the Toronto Board of Trade of which he had long been an executive.

CORRESPONDENCE

Dominion Bridge Company Limited
Lachine, Que.
November 28th, 1935

To The Editor,
The Engineering Journal,

Dear Sir,

The interim report of the Consolidation Committee, which appears in the November Journal, must be disappointing to those who are anxious to solve the problem of organization of the Profession of Engineering in such a way as will serve the public and at the same time be of credit and advantage to the engineers themselves.

The Committee's report is merely a summary of the yeas and nays to the Questionnaire and it gives no further enlightenment as to the main principles and aims underlying Consolidation. Surely some of the remarks received from the members who replied to the Questionnaire bear on the question of objective and are worthy of consideration by the membership at large.

The correspondence by Mr. Wheatley in the same issue of the Journal and that of Mr. Pratley in the July number is more useful as it brings out clearly two divergent views on the general question of re-organization of the Engineering Profession. Mr. Wheatley bases his arguments on the recompense to which the individual engineer is entitled who has acquired a certain amount of conventional knowledge and believes in conferring upon him a mark of distinction which would carry a preference in obtaining employment. Mr. Pratley, on the other hand, bases his arguments on the profession's responsibility to the public by making the license a genuine mark of qualification and by making the Institute the path of advancement in the science of engineering.

It becomes apparent that the real controversy is over the extent to which the license permits its holder to practise engineering, and it is therefore the duty of the Committee on Consolidation to define clearly what it desires to accomplish by means of the license. It is imperative that it should be decided whether this is possible and if this licensing will benefit both the engineer and the public.

That there is need for licensing of engineers may be conceded, as very few will deny this desirability. Many of us go even farther and believe that most engineering work should be done under the legal responsible charge of a licensed engineer who is quite independent of the commercial side of the undertaking; but there are differences of opinion as to what the licensing is to accomplish. It must certainly be of some more tangible benefit than that of being merely a title or permit to employment. The various Provincial governments must have considered the license to be of benefit to the public when they passed laws granting the right to limit the practice of engineering to certain qualified persons, but is there any valid reason for licensing an employee whose employer is responsible for his doings?—especially when it must be acknowledged that an employer is a far better judge of the fitnessof the employee than a board of examiners none of whom may be experieneed in the particular line in which the applicant seeks to be employed. The university degree carries with it a far more useful indication of the potential value of the applicant than any license that can be issued by an examining body of the present organizations.

Commercial trading is not a profession nor does any learned profession recognize it as such; therefore, it should be clearly defined as to where the dividing line lies between engineering as a trade and engineering as a profession, as no lasting good would be accomplished by a policy which refuses to see that all engineering is not professional. Engineering is so closely allied to trade and so much of the most difficult and specialized designing is performed for competitive trading, that to debar commercially engaged engineers from our membership would prove fatal and exclude the greatest source of usefulness and progress. It is felt therefore that the Institute should include those engineers who are engaged for trading purposes, but that the license should be restricted to those who are uninfluenced and untrammeled by commercial considerations.

The definition of the exact meaning of "practice" and also of the term "rigid strictly professional body" applied to the various duties performed by engineers would help to clear up the differences of opinion far more effectively than bemoaning the fact that we are not as other professions are.

The whole question of Consolidation with all its ramifications, presents a very grave problem to those engineers who hold their vocation as something more serious than the mere means of gaining a livelihood. The members of the Institute are therefore looking hopefully to the Committee on Consolidation, trusting that it will have investigated all those controversial matters which concern their moral and intellectual standing, and which must affect the usefulness of the Institute. It is also hoped that this committee will present the result of such investigation clearly, explicitly and distinctly to the membership, before recommending any consolidation plan which might be binding for many years and which might prove, in the impossibility of its consistent application, to be an unsatisfactory disposition of the privileges which the Engineering Institute now enjoys.

Very truly yours,
F. P. Shearwood, M.E.I.C.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

Friday evening, October 18th, 1935, the Border Cities Branch held its first meeting after the summer adjournment, with twenty-two persons present.

J. Boyd Candlish, A.M.E.I.C., who is well known for his papers on the Diesel engine and his association with the "Power House" magazine, was the speaker for the evening, his subject being "Blended Fuels for Internal Combustion Engines."

BLENDED FUELS FOR INTERNAL COMBUSTION ENGINES

At the present rate of using crude oil for power engines, Mr. Candlish predicts that within fifteen to twenty years the supply will be diminished to the point where the price will be so high as to make it impractical as a fuel for internal combustion engines. At the present time a good deal of discussion and research is being carried on in the use of blended fuels to replace gasoline. This work is not new, as practically all there is to know with regard to the hydro-carbon group of alcohol-gasoline, hydrogen-gasoline and acetylene-gasoline was uncovered prior to the war.

The speaker believed that the subject of blended fuels will become one of a political nature in the near future. In the case of the domestic market, blended fuels will use up surplus grain supplies and thus aid the farmers. The foreign markets trend is towards blended fuel to save importing so much gasoline and to maintain a favourable trade balance.

A number of slides giving details and tables of actual experiments by Mr. Candlish were then shown. In all cases the mixtures used were gasoline and mixtures of gasoline with 5, 10, 15 and 20 per cent alcohol. First tables showed the theoretical values of the five mixtures. Other tables gave the results of using the mixtures in a standard automotive engine and then with various variations in the design of engine and carburetor adjustment. The general conclusions were that the use of blended mixtures in present-day engines would increase driving costs. However, with an ideal engine, designed to take full advantage of the highest useful compression-ratio, the cost of mileage to the motorists decreases enough to more than take care of increases in the cost of fuel.

With the use of alcoholic mixtures the cork parts, etc. would have to be replaced by metallic ones; the car would not be as easy to start as with gasoline owing to the high boiling point of alcohol, but smoother running would be obtained, for alcohol is a good doping agent against anti-knock; as for its effect on lubrication, the general opinion is that the blended mixture would not affect it.

A very interesting discussion followed, with suggested sources, starting qualities and substitutes for blended mixtures taking the main part. T. H. Jenkins, A.M.E.I.C., commended the paper highly and moved a vote of thanks to Mr. Candlish which was extended to the speaker by the Branch chairman, H. J. Coulter, A.M.E.I.C.

Edmonton Branch

R. M. Hardy, S.E.I.C., Secretary-Treasurer.

The winter activities of the Edmonton Branch of The Engineering Institute of Canada were commenced on October 31st, 1935, at the Macdonald hotel, when a banquet was held jointly with the Edmonton members of the Association of Professional Engineers of Alberta, and the northern Alberta Branch of the Canadian Institute of Mining and Metallurgy, in honour of the Right Honourable Sir Montague Barlow, Bart., P.C., K.B.E., etc., Chairman, Alberta Coal Commission; the Honourable Charles C. Ross, R.P.E., M.E.I.C., Minister of Lands and Mines of the Province of Alberta, and Mr. William Armour, M.I.Min.E., Technical Advisor to the Alberta Coal Commission.

F. K. Beach, M.E.I.C., chairman of the Branch, presided. A welcome to the guests was extended by Mr. F. J. Mitchell on behalf of the northern Alberta Branch of the C.I.M.M., and by A. W. Haddow, A.M.E.I.C., on behalf of the Association of Professional Engineers. Other speakers included J. D. Baker, M.E.I.C., W. J. Dick, M.E.I.C., Dr. J. A. Allan, and Mr. John Martland who brought greetings from the Alberta Association of Architects.

Mr. Armour, speaking as one of the guests and as a native of Scotland, gave a very entertaining talk during which he commented on the surprising number of his countrymen who held responsible positions in the coal industry of this province. He also expressed an appreciation of the high degree of skill evident in the mining operations of the province.

Sir Montague Barlow, as principal speaker of the evening, paid tribute to the great achievements of the engineering profession in the various parts of the Empire. He also expressed admiration for the accuracy of the engineer's figures, the elasticity of their estimates, and the bigness of their ideas. Speaking in more serious vein, he referred to the great problems confronting Canada due to the fact that it is a land economically geared-up for a population of 20,000,000 and at present has only one-half of this. At the same time, he said, these problems presented great opportunities for leadership and service to the engineering profession in this country.

During the summer months the activities of the Branch were as usual curtailed. However, a very pleasant social gathering was held on August 10th when the members and their families where the guests of the Branch chairman, F. K. Beach, M.E.I.C., and Mrs. Beach at their summer home at Kapasiwin Beach.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

"Diesel Engine Design, 1897 to 1935," was the subject of a talk given by E. F. Roberts, general manager of Jordan-Roberts Sales Ltd. of Brantford, to the Hamilton Branch on the evening of November 12th, 1935. Mr. Roberts gave a historical sketch of the Diesel engine and explained the development that had taken place since 1897 and the steps taken to approximate the Carnot heat cycle in this engine which is the most efficient that has been developed, giving up to 35 per cent efficiency.

First cost per horse power is greater in the large units than in the medium, hence the recommendation to use multiple medium size units in an installation rather than one large unit.

Mr. Roberts showed a series of slides illustrative of the points he dealt with such as PV curves, fuel injection, and combustion space. He touched on the semi-Diesel, described the methods of starting, and pointed out the improvement following the use of the Comet head which cuts down the exhaust fumes.

Aeroplane Diesel engines are now made of 1 pound per horse power deadweight and 2,200 r.p.m. The oil fuel required for this engine does not incur the fire hazard of the gasoline tank, a specially dangerous feature in aeroplanes with gas engines.

Many tugs on the Thames are now Diesel engined, showing many advantages over steam—one engine operator, and less engine and fuel space being noticeable. These engines are reversible and easily operated from one control point.

Moving pictures showed the work done in the plant at Stockport where the "Mirrlees" engine is made. It is interesting to note that the first Diesel engine made in Britain by Mirrlees Watson of Glasgow in 1897, is still operating satisfactorily.

In the automotive industry Diesel engines are widely used in trucks and busses, but in the passenger car certain problems have to be overcome. The car driver of to-day must have an engine that will start easily, that will run without vibration at all speeds, and that will operate over a wide range of temperatures without a falter, and this is asking a great deal of a high compression oil fuel engine.

After the lecture, questions were asked, some involving technical points, which Mr. Roberts kindly explained.

D. W. Callander, A.M.E.I.C., moved a vote of thanks, which was heartily accorded the speaker.

The meeting was held in the Science building, McMaster University. There were about sixty present. Mr. Hollingworth occupied the chair, and at the close announced that the following meeting on December 9th would take the form of a Students contest, five students or juniors having promised papers. Refreshments were enjoyed in an adjoining room.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.

Forty-three members and guests of the Lethbridge Branch visited the sugar factory at Picture Butte on Saturday, October 26th, 1935.

The inspection began with a trip to the large storage reservoir, north of the town, which has a capacity of 1,300 acre-feet of water. The dam is 7,000 feet long, 16½ feet high and rip-rapped with rock over a gravel bed on the inside slope. Underneath the dam is a clay core wall

View from Canadian Sugar Factories, Picture Butte, Alta.

16 feet deep for under drainage. The main water line from the reservoir to the factory is 3,300 feet long, constructed of 20-inch wood stave pipe.

The groups then inspected the various jobs going on about the factory site.

Dinner was served in the company's dining hall at 6 p.m., W. L. McKenzie, A.M.E.I.C., chairman of the Branch, gave a short address of welcome, following which Mr. I. B. Tucker made a short speech. Community singing was enjoyed, ably led by Wm. Meldrum, A.M.E.I.C.

Visit to Canadian Sugar Factories Plant.

C. S. Clendening, A.M.E.I.C., introduced the speaker of the evening, Mr. C. Bentall, president of the Dominion Construction Company.

In opening his remarks, Mr. Bentall stated that foundations are a primary consideration. First the financial foundation; and the B.C. Sugar Refining Company and the Canadian Sugar Factories are capable of carrying a fair load in this respect. Secondly the human factor; and the company has shown that it has the welfare of its employees at heart, in shortening hours, pensioning schemes, keeping up employment and wages, not at the expense of the public, but through increased efficiency.

In building a sugar factory choice of a site is important. The final choice in this case rested between Diamond City and Picture Butte, and on April 19th, it was decided to build at the latter location.

Some of the factors considered were: central to the beet growing area on the L.N.I.D., water storage facilities and length of pipeline from the reservoir, waste and waste water disposal, length of railway connection and availability of good sand and gravel.

On May 13th, pile driving commenced and 752 B.C. fir piles were driven under the bulk storage bins with a penetration of from 13 to 18 feet.

Following the taking of soil tests the footings were laid; these being designed for a load of 4,000 pounds per square foot. Thus the footings under the high sugar end which will carry a load of 350 tons, are 13 feet 2 inches square.

There are seven railway lines on the factory site, totalling 5,000 feet.

The beet storage occupies an area 300 feet by 400 feet and has seven concrete beet flumes leading into the factory.

The factory is a steel frame structure, with brick walls and concrete floors, and the roofs are made of a fireproof and weatherproof roofing called Transite, which is composed of concrete and asbestos.

The machine shop is well equipped and above this shop is the store-room. The office building is a three-storey structure and in the basement is the heating plant, showers, wash-room etc.; on the first floor the general office and on the top the laboratory.

There will be a power house, filtration plant and boiler house. Electrical power is used for most of the machines. Steam for the process work of the factory will be supplied by two boilers consuming some 10,000 tons of slack coal a year.

The packing room is a high building and the sugar will be taken to the top of this building and distributed to the various packing machines by gravity. In this building are also the beet seed and material warehouses.

The bulk storage is the second largest on the continent, and consists of six conical cylinders, 33 feet in diameter and 85 feet high, lined with two layers of 7/16 fir separated by wax paper and kept away from the concrete walls by 2 by 2 inch sticks.

The pulp silo is large, lined with timber and has car loading facilities.

About the whole project is an air of permanence and real efficiency and comfort.

J. B. DeHart, M.E.I.C., with a few well-chosen words thanked Mr. Bentall, his staff and the Sugar Company for an excellent afternoon's entertainment. The vote of thanks was tendered by Mr. McKenzie and heartily endorsed by all present.

Mr. W. T. Hill spoke on behalf of the Lethbridge Board of Trade and Mayor D. H. Elton on behalf of the city of Lethbridge.

London Branch

S. G. Johre, A.M.E.I.C., Secretary-Treasurer.
J. R. Rostron, A.M.E.I.C., Branch News Editor.

The Association of Professional Engineers of Ontario held their October meeting at the Hotel London in this city, on October 25th, 1935, and, as a cordial invitation was extended to all professional engineers in this district and to members of the London Branch of The Engineering Institute of Canada, no regular monthly meeting of the London Branch was held.

The Council of the Association held their business session in the morning, and the members of the Association and of The Institute assembled at the London Hunt and Country Club for luncheon, by the kind invitation of Colonel I. Leonard, M.E.I.C.

The luncheon was much enjoyed and thoroughly appreciated as it formed a good "get together" meeting.

It was a fine day and some of the members spent the afternoon in a game of golf while others were driven to various places of interest in and around the city.

A full dinner meeting was held at the hotel at 7 p.m., the president, J. Clark Keith, A.M.E.I.C., taking the chair. Proceedings were opened by the chairman who stated that the purpose of the meeting was to obtain the views and suggestions of the local engineers and members of the Association with regard to the matter of the proposed organization of the various Provincial Associations of Professional Engineers, with the ultimate view of combining them with The Engineering Institute of Canada. He called upon Col. I. Leonard, past-president, and upon A. Crealock, M.E.I.C., to say what had been accomplished in this direction, and also the present state of affairs.

This was done very clearly by these gentlemen and the meeting was then thrown open by the chairman for the expressions of opinions and suggestions of the members.

Amongst those who spoke were Professor Graham (Mining, Queens University), Mr. W. H. Riehl (City Engineer, Stratford), Mr. Brodsky (Brantford), Mr. E. T. Sterne, Professor R. W. Angus, M.E.I.C. (Mechanical Engineering, Toronto University), E. V. Buchanan, M.E.I.C. (Manager, Public Utilities Commission, London), and J. R. Rostron, A.M.E.I.C.

Approval of the continuance of the Committee of Eight was voiced and the suggestions ran along the lines of standardization of qualifications for admission to all the Provincial Associations together with uniform legislation for each province as a preliminary to combining the Association and The Institute.

A mention was also made of sub-dividing the Associations into separate bodies for each class of engineering such as civil, mechanical, electrical, mining, etc., while still being under the one head.

Many useful hints along these lines were given and no doubt the Committee of Eight will consider them.

The meeting concluded with votes of thanks to the chairman, Col. I. Leonard, and Mr. A. Crealock.

Montreal Branch

C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.

THE EVOLUTION OF THE WAR SHIP

On October 10th, 1935, Engineer Commander A. D. M. Curry, R.C.N., M.E.I.C., Director of Naval Engineering, Department of National Defence, gave a most interesting talk on the evolution of the war ship, with particular reference to the developments following the early introduction of steam. The address was illustrated by a series of excellent slides, covering ships and equipment used since the earliest days of the British Navy.

F. S. B. Heward, A.M.E.I.C., acted as chairman.

VOICES ACROSS THE SEA

On October 15th, 1935, Dr. J. O. Perrine, Associate Editor of the Bell System Technical Journal, delivered an exceedingly interesting lecture before members of the Montreal Branch of The Institute and the Sigma Chi Society, at Moyse Hall, McGill University.

Speech was shown to be made up of a series of component waves which could be seen in action, and by the aid of slides and electrical equipment the sound of the human voice was analyzed from the time it left the mouth to the impulse on the auditory nerve leading to the brain of the listener. The entire audience listened-in on a conversation between two people in Moyse Hall and Dr. A. S. Eve, of McGill, and A. E. Barney of the American Telephone and Telegraph Company, both in London, England. The talk was illustrated with lantern slides and equipment.

The chairman was Dean Ernest Brown, M.E.I.C.

A NATIONAL SLUM CLEARANCE AND HOUSING PROGRAMME

On October 17th, 1935, Mr. James H. Craig, a Toronto architect spoke on the above subject, describing Canadian conditions and outlining a scheme whereby unemployment could be relieved by a national project of this nature. Suggestions were made for the financing of such a project.

Prior to the meeting a dinner was held at the Windsor hotel. G. McL. Pitts, A.M.E.I.C., was in the chair.

DIRECT CURRENT TRANSMISSION

On October 23rd, 1935, Mr. C. W. Stone, consulting engineer of the General Electric Company, Schenectady, N.Y. gave an interesting paper and demonstration on the development of direct current transmission. This system places full control in the hands of the operator who can at all times control not only the amount of power flow but its direction.

Previous to the lecture an informal dinner was held in the Windsor hotel. Dr. F. A. Gaby, M.E.I.C., President of The Institute, was chairman.

JUNIOR SECTION

On October 28th two papers were presented before the Junior Section, one by E. R. Smallhorn, A.M.E.I.C., on Junior Section Activities, and the other by T. R. Durley, JR.E.I.C., on "Kilns and Cement Burning."

Alex. Shearwood, S.E.I.C., was in the chair.

NICKEL AND ITS ALLOYS

T. H. Wickenden, assistant manager of the Development and Research Department of the International Nickel Company, Inc., New York, on October 31st gave a historical survey of the development, application and uses of nickel and its alloys. The talk was illustrated with motion pictures and consisted of a review of the nickel industry and interesting statistics of industrial applications. The chairman was R. S. Eadie, A.M.E.I.C

METHODS OF POWER FACTOR CORRECTION

British methods of power factor correction were explained by Mr. B. M. Burt, chief engineer of Bepco Canada Limited, on November 4th. The talk dealt not only with synchronous motors and condensers but with auto-synchronous motors, phase advancers and compensated induction motors. Walter J. Armstrong, M.E.I.C., was in the chair.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The Niagara Peninsula Branch held a dinner meeting at the King Edward hotel, Niagara Falls, on October 22nd, 1935, at which Mr. O. W. Titus, chief electrical engineer of the Canada Wire and Cable Company, was the speaker.

Although Mr. Titus dealt principally with the transmission line and electrical conductors, he prefaced his talk with some broad general details of the development along the Colorado river and showed several films illustrating the project, as well as the spinning of the new type HH conductor, the mechanical details of which were explained by Mr. H. B. Carnahan.

Paul E. Buss, A.M.E.I.C., was in the chair, and vice-chairman G. H. Wood, A.M.E.I.C., introduced the speaker as an old friend, who had served part of his apprenticeship in the Niagara district.

Ottawa Branch

F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.

FROM SAIL TO STEAM IN THE ROYAL NAVY

The course of British naval development from the crude ships of the early Britons to the fighting floating machines of the present day was graphically traced by Engineer-Commander A. D. M. Curry, M.E.I.C., of the Royal Canadian Navy, in an illustrated evening lecture held by the Ottawa Branch at the auditorium of the National Research Laboratories on October 29th, 1935. Dr. R. W. Boyle, M.E.I.C., chairman of the Branch, presided at the meeting which was the opening event of the fall and winter season. To this meeting the general public, including the ladies, were specially invited and there was a good attendance.

The remarkable advances, in particular during the past century, were elaborated upon by the speaker including the introduction of iron and then of steel in place of wood construction, the substitution of steam power for sails, using first the paddle wheel and then the screw propeller, and of various types of engines leading up to the efficient types of today. During the past half century, it was revealed, the size of the modern battleship has been quadrupled and its speed doubled.

Dr. Boyle, previous to introducing the speaker, referred to the great loss sustained by The Institute and by the engineering profession generally in the death on the previous day of Noulan Cauchon, A.M.E.I.C. Mr. Cauchon had been a chairman of the Branch, had held other offices in The Institute, and was one of its outstanding members.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

Depuis son assemblée annuelle du 20 mai 1935, la Section de Québec a tenu trois réunions générales de ses membres comme suit:—

VISITE AU CAMP VALCARTIER

Cette visite eut lieu le 15 juin dernier; M. Alex Larivière, M.E.I.C., présidait à cette réunion des membres qui furent conduits sur les lieux par le Lt.-Col. J. B. Dunbar, A.M.E.I.C., et le Capt. A. J. Kerry, A.M.E.I.C., tous deux membres de notre section et attachés au service du district militaire No 5.

Au cours de cette visite nos membres ont rencontré tous les officiers du camp, entre autres deux de leurs confrères dont l'un, M. C. B. Bate, A.M.E.I.C., est ingénieur en charge du projet Valcartier et l'autre, M. G. D. O'Connor, A.M.E.I.C., est en charge de la fabrication des blocs de ciment servant à la confection des murs des diverses constructions.

A Valcartier l'on est à ériger un groupe de bâtisses destinées à remplacer la fabrique de cartouches qui est actuellement près du manège militaire de Québec; de plus on y construit des huttes qui serviront plus tard aux fins d'entraînement militaire et, entre temps, ces huttes sont occupées, dès leur complétion, par les chômeurs concentrés au camp Valcartier.

Ces constructions entraînent beaucoup d'autres travaux tels que chemins, lignes de transmission, aqueduc, égouts, etc.; en autant que possible ces travaux sont exécutés manuellement et avec des matériaux puisés dans les limites mêmes du camp.

Tous ceux qui ont pris part à cette excursion ont été vivement intéressés et Monsieur A. Larivière, M.E.I.C., président de notre section, se fit leur interprète pour remercier le Lt.-Col. Dunbar et tous les autres officiers du camp pour l'instructive visite qu'ils leur avaient fourni l'occasion de faire et pour leur cordial accueil aux visiteurs.

RÉUNION GÉNÉRALE

Deux jours plus tard, soit le 17 juin dernier, nos membres se réunissaient de nouveau, dans une salle du Château Frontenac, pour considérer le questionnaire soumis par le "Committee on Consolidation" et répondre aux questions qui y étaient posées; cette réunion était présidée par Monsieur Larivière et les réponses de notre section au questionnaire ont été transmises à qui de droit.

VISITE A LA ROCK CITY TOBACCO COMPANY LIMITED

Le 24 octobre dernier, nous avions la bonne fortune de visiter l'une des plus grandes industries de la cité de Québec, la Rock City Tobacco Co., Ltd.; aimablement reçus par M. A. C. Picard, vice-président de la compagnie, les visiteurs ont fait le tour de l'établissement en compagnie de quelques officiers de la Rock City et c'est ainsi qu'ils ont pu suivre, avec de nombreux renseignements, les différentes phases par lesquelles passe le tabac avant d'être mis sur le marché sous forme de tabac à fumer ou à chiquer, de cigarettes, cigars, etc.

Les machines qui servent aux différentes opérations sont fort intéressantes à voir fonctionner, particulièrement celles qui servent à la mise en paquets du tabac de même que celles qui servent à la fabrication des cigarettes et à leur empaquettage.

Cette visite fut des plus intéressantes et en l'absence du président de notre section, son vice-président, Monsieur T. J. F. King, A.M.E.I.C., adressa à Monsieur Picard et aux autres officiers de la compagnie des paroles de remerciements sincères tant pour l'aimable invitation de visiter leur usine que pour le chaleureux accueil fait aux visiteurs.

Avant de partir chacun fut cordialement prié de prendre, sur une table chargée à profusion des produits de la compagnie, un échantillon à son choix; tous se rendirent à cet appel généreux qui mettait fin à une réunion instructive organisée par M. Théo. M. Déchène, A.M.E.I.C., membre de notre Comité d'Excursions.

Sault Ste. Marie Branch

H. O. Brown, A.M.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch held the October monthly meeting at the Windsor hotel, Sault Ste. Marie, Ont., on Friday evening, October 25th, 1935.

As the evening meeting was to be an open one for members and guests from the various local industries, the business meeting was held at 6.15 with chairman Frank Smallwood, M.E.I.C., presiding. Following the business meeting dinner was served at 6.45 when fifty-four members and guests sat down.

ROLLER BEARINGS

At 8 p.m. the meeting was turned over to Mr. J. L. Young, assistant general manager of the Timken Roller Bearing Company of Canton, Ohio. Mr. Young gave a brief history of the development of the Timken roller bearing from the tapered waggon and buggy wheel bearing. Then a brief review was given of the introduction of these roller bearings into various industries which required the manufacture of larger and larger sizes until now bearings of 3 and 4 tons are in service.

Then followed a series of moving pictures illustrating the use of roller bearings in various industries. These pictures included:

Goss Printing Press of the Chicago Tribune.
Otis Steel Corporation—hot and cold strip mills.
Inland Steel Corporation—hot strip mill.
Timken equipped locomotives.
Carnegie Steel Company—52-inch beam mill.
Champion Coated Paper Co.—paper mills.

In addition to the above some scenic coloured moving pictures were shown to illustrate the wonderful colour effect that can be obtained with this recent development.

A very hearty vote of thanks was extended to Mr. Young for his talk and the moving pictures presented.

Toronto Branch

W. S. Wilson, M.E.I.C., Secretary-Treasurer.
N. MacNicol, M.E.I.C., Branch News Editor.

Some Problems of Transportation

On Thursday, October 17th, 1935, a luncheon meeting was held at the Royal York hotel. There were approximately ninety present to hear a paper given by Dr. F. A. Gaby, M.E.I.C., on "Some Problems of Transportation."

Dr. Gaby referred to the many complications in the transport problem outside the control of the industry itself. The advent and improvement of the internal combustion engine has been one of the greatest factors in the development of modern forms of transport. Economic causes have had a considerable influence, particularly important being the effects of the trade depression on the heavy industries. Motor-vehicle registrations in Canada have increased from 535 in 1904 to 1,129,532 in 1934. During the same period improved highways have been rapidly extended until in 1934 there was a total investment in provincial highways throughout Canada of 204 million dollars, representing 35 per cent of the entire provincial indebtedness.

He also referred to the increasing use of Diesel engines for economy in fuel consumption, both by railways and truck operators. Conditions in United States, Europe, England and Ireland were referred to. The rapid strides being made in air transport was also mentioned.

The speaker was of the opinion that in a properly co-ordinated transport system, the railway should assume the main burden of carriage of goods over distances exceeding 100 miles, and the trucks should operate as collectors and distributors of freight.

A hearty vote of thanks to Dr. Gaby was moved by Colonel C. S. L. Hertzberg, M.E.I.C. W. E. Bonn, M.E.I.C., chairman of the Branch, presided at the meeting.

Aircraft Development in Europe

On Thursday evening, November 7th, 1935, a meeting was held at Hart House, at which there were approximately one hundred and twenty-five present to hear an address by Professor T. R. Loudon, M.E.I.C., on "Aircraft Development in Europe."

The lecture was well illustrated by slides showing the many types of aeroplanes now in use in Europe and the number of regular air-routes extending many thousands of miles. Professor Loudon outlined the rapid growth taking place in air transport in many European countries, and stated that it was now possible to make the trip from Croydon field to Africa and return, a distance of 2,300 miles, in one day. During the last week of July 1935, 31,146 passengers were carried from Croydon field to Paris.

The speaker also referred to the splendid meteorological service in Europe giving accurate up-to-the-minute weather reports to all aerodromes. Pictures were shown of large wind tunnels built in United States and England for testing and research on full size aeroplanes.

After completion of his paper, Professor Loudon gave a brief talk on impressions received in England, Belgium and Germany during a trip made last summer. A hearty vote of thanks was moved by J. M. Oxley, M.E.I.C.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

The Flow of International Rivers into Manitoba

A paper of considerable interest was presented on October 17th, 1935, by Professor Elwyn F. Chandler, Member A.S.C.E., hydraulic engineer, U.S. Geological Survey, Professor of Civil Engineering and Dean Emeritus of the College of Engineering, University of North Dakota, Grand Forks, on the above subject.

The runoff of a watershed is the remainder of the precipitation left after evaporation and transpiration have taken their share. In Manitoba, Saskatchewan and North Dakota it is the remainder, if any. For this area, the annual rainfall measured in inches, minus 20 inches for evaporation and transpiration, closely equals the runoff. Therefore the runoff varies widely, even though the total annual rainfall in this area almost never varies more than 50 per cent above or below the long term average.

For fifty-three years, the Red river at Grand Forks had a maximum total recorded flow for any one year (1882 and 1916) 2½ times the normal long period average, and a minimum total recorded flow (1934) as low as one-tenth the average. The similar variations in the Pembina at Neche, N.D., are maximum (1904) 4 times the average, and minimum (1915) one-seventh the average. For the Souris river at Minot, the maximum (1904) was 5 times the average, the minimum (1931) one-one hundredth of the average. The rates of flow show extremes for the Red at Grand Forks of 42,400 c.f.s. (1897) and 20 c.f.s. (1934); for the Pembina 3,850 c.f.s. (1904 and 1913) and 1 c.f.s. (1925); for the Souris 12,000 c.f.s. (1904) and zero c.f.s. (frequently).

Intensive drainage has increased both runoff and speed of runoff. On the other hand, the plowing up of the land, thereby breaking up the hard surfaced native buffalo prairie, has increased the receptivity of the land to the rainfall, thereby diminishing runoff.

An excellent opportunity for a combined storage and flood prevention reservoir exists at Red Lake, Minnesota. This lake has an area of 440 square miles. If the upper 6 feet of level were controlled by a dam, then 3 feet could be used for storage and 3 feet for flood prevention, which could be operated to reduce the largest floods on the Red river by about one foot at Grand Forks.

Those taking part in the discussion which followed included T. C. Main, A.M.E.I.C., D. L. McLean, A.M.E.I.C., C. H. Attwood, A.M.E.I.C., J. T. Rose, A.M.E.I.C., and C. P. Haltalin, A.M.E.I.C. A vote of thanks proposed by Dean E. P. Fetherstonhaugh, M.E.I.C., was heartily concurred in by the large audience.

Ontario Supreme Court Decision of Interest to Engineers

A Supreme Court decision affecting the engineering profession in Ontario has been rendered by Mr. Justice Kingstone, in dismissing a motion to compel the granting of a membership in the Ontario Association of Professional Engineers.

The case arose out of the predicament of an Ontario engineer, a non-member of the Provincial Association, who moved to the United States and sought registration in that country. This was denied him unless he could show membership in the Ontario association or unless he abandoned his Canadian citizenship. Accordingly he applied for registration in the Ontario association. Membership had been open to him during his years of residence in Ontario but he had postoned application. When he applied in Ontario while a resident of the United States, his application was refused by reason of the restriction of membership in the Ontario association to residents of the province.

The engineer took proceedings in the Supreme Court of Ontario to compel registration, contending that Section 12 of the Professional Engineers' Act did not require residence in Ontario. The court disagreed with him and dismissed his proceedings, holding that no engineer could acquire membership in the association unless he resided in Ontario at the time of his application.

Gasoline Losses from Storage Tanks

Two-thirds of the gasoline losses from unprotected storage tanks can be avoided by covering the tank with aluminum paint or whitewash and even greater savings can be effected by insulating the parts of the tank exposed to the sun, according to a report recently issued from the Division of Research Information, National Research Council, Ottawa, on evaporation from gasoline storage tanks under the influence of the sun's radiation. The subject is of considerable economic importance since it is probable that the combined oil storage capacity in Canada is not less than 500,000,000 gallons. The problem is to prevent the small percentage losses which arise from the heating of tank surfaces during bright sunny days and the cooling of the metal at night.

When a gasoline storage tank is nearly filled, the air above the liquid becomes saturated with gasoline. Then, when the sun shines on the tank, the vapour expands as it becomes warmer and escapes through the vent. Later, when the tank cools off as at night, the vapour contracts and draws in fresh air which in time becomes saturated with more gasoline. The process repeats itself daily. Losses from an 80,000-barrel tank may run above two barrels a day during the summer months.

Several methods may be employed to reduce the variations in temperature of the oil and vapour in storage tanks. Of these the simplest precaution is to reduce to a minimum the area exposed to the sun's rays and to coat the surface with paint or other material which has a high reflecting power such as aluminum or magnesia.

Insulation either as a special coating of plaster or as a second housing mounted on a steel frame can be used. It has been calculated that four inches of a good insulating material would reduce the temperature variation over the surface of a storage tank to about one-third of that observed on an unprotected tank. The effects obtained by insulation can be further improved by the use of highly reflecting surfaces, as for example aluminum foil.

In large installations cooling systems and means for trapping the vapours by connecting the storage tanks with gasometers similar to those used in cities for the storage of illuminating gas may be employed. Other plans provide for a pan-type floating roof, various types of breather roofs and pontoon roofs, all of which are described.

A copy of the report may be obtained on application to the National Research Council at Ottawa.

Preliminary Notice

of Applications for Admission and for Transfer

November 25th, 1935

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

Communications relating to applicants are considered by the Council as strictly confidential.

The Council will consider the applications herein described in January, 1936.

R. J. DURLEY, Secretary.

*The professional requirements are as follows.—

A Member shall be at least thirty-five years of age. and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge

An Associate Member shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility. in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professiona responsibility for five or more years.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A Student shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

BARCLAY—JAMES BOW, of Vancouver, B.C., Born at Gourock, Scotland, Mar. 18th, 1903; Educ., Daniel Stewart's College, Edinburgh, 1917-21. R.P.E. of B.C. by Exam., 1929; 1921-24, ap'ticed struct'l. engr., and 1924-27, asst. engr., Palmer & Turner, Archts. and Engrs., Shanghai, China; 1928, asst. engr. ,Cons. Mining & Smelting Co.; 1928-30, asst. engr. and dftsman., Townley & Matheson, Stuart Cameron & Co., and B.C. Elec. Rly. Co.; 1930, chief concrete design on Burrard Bridge for J. R. Grant, M.E.I.C.; 1931, engr. and dftsman on design of govt. pier, for Sydney E. Junkins, M.E.I.C.; 1932-33-34 (not continuously), designer and dftsman. for John S. Metcalf Co.; 1930-35 (not continuously), engr., estimator and supt., on various projects, for Northern Construction Co.; 1934, steel detailer, Dominion Bridge Co.; 1935, chief concrete designer, Fraser River Bridge, for W. G. Swan, M.E.I.C.; 1935, consltg. struct'l. engr., associated with C. Elwood Walkins and Graham Johnson, Architects, in complete charge of struct'l, design of steel and concrete for Federal Bldg., Victoria, B.C.

References: J. R. Grant, W. G. Swan, A. S. Gentles, E. F. Carter, J. Robertson C. T. Hamilton.

BEANEY—SYDNEY WILLIAM, of 125 Erskine Ave., Toronto, Ont., Born at Liverpool, England, July 15th, 1905; Educ., 1919-24, Central Technical School, Toronto; 1927-31, dfting. and supervn. of constrn. for Baldwin & Greene, Watt & Blackwell, T. Eaton Co., H. L. Allward, Arch't.; 1931 to date, sales engr., Joseph Taylor & Son, Mfrs. Agents, Toronto. (Applying for admission as an Affiliate of the Institute.)

References: W. B. Redman, H. N. Gzowski, R. G. Saunders, H. E. Brandon, N. G. McDonald.

CASSIDY—STANLEY BERNARD, of 48 Fleet St., Moncton, N.B., Born Sussex, N.B., Mar. 7th, 1912; Educ., B.Sc. (E.E.), Univ. of N.B., 1933; 1932-33 (during senior year), asst. in elect'l. engrg., Univ. of N.B.; 1933 (6 mos.), head of geophysical party, N.B. Gas & Oilfields Ltd.; 1935 (1½ mos.), asst. on geological survey. (1 mo.), geogolical computations; at present, temp. employment with T. Eaton Co. Ltd., Moncton, N.B.

References: J. Stephens, A. F. Baird, E. O. Turner, G. L. Dickson, V. C. Blackett.

HOLDCROFT—JOHN BARBER, of 832 Cumberland Crescent, North Vancouver, B.C., Born at London, England, Aug. 24th, 1884; Educ., Private study. Passed Can. Soc. C.E. Exams. for Junior, 1912, for Assoc. Member 1913; 1904-08, rodman, asst. dftsman., computer and instr'man., Victoria, B.C.; 1909-10, surveyor and engr., Gore & McGregor, Land Surveyors and Engrs.; 1910-12, asst. engr., City of Victoria, B.C.; 1912-13, in own business, engrg. and constrn.; 1913, dftsman, Dept. of Lands, B.C., Forest Br., Dept. of Rlys., B.C.; 1914-18, overseas, Can. Engrs., Lieut. in charge of camp constrn. and mtce.; 1918, mine surveyor, Crow's Nest Pass Coal Co.; 1919-20, asst. engr., Dept. of Rlys., B.C.; 1920-22, private engrg. and constrn. work; 1922-23, designing dftsman., hydro-electric, Portland Elec. Rly., Light & Power Co., Portland, Oregon.; 1923 to date, hydraulic engr., and asst. mgr. from 1929, Pacific Coast Pipe Co. Ltd., Vancouver, B.C. In charge of design and supervision of constrn. of wood stave pipes, penstocks, tanks, etc., throughout Canada and Nfld. Also design and constrn. of paper mill equipment. Also engaged from time to time as private consultant on special questions involving hydraulic structures in timber constrn. and on hydro power development.

Reference: J. C. MacDonald, C. Brakenridge, E. A. Cleveland, A. E. Foreman, A. S. Wootton.

JOHNSTON—ORVAL ELLSWORTH, of 941 Roberts St., Niagara Falls, Ont., Born at Summerstown, Ont., Mar. 16th, 1906; Educ., B.A.Sc., Univ. of Toronto 1934; 1926-30, dftsman., hydraulic dept., H.E.P.C. of Ontario; Summer 1931, field engr's asst., Morrow & Beatty Ltd.; May 1934 to date, engrg. asst. dftsman., H.E.P.C. of Ontario, Niagara Falls, Ont.

References: O. Holden, A. E. Nourse, C. R. Young, W. J. Smither, W. Jackson.

KELLY—WILLIAM NIELSON, of Vancouver, B.C., Born at Douglas, Isle of Man, Sept. 9th, 1873; Educ., 1901-02, Liverpool University; 1888-1893, ap'ticed Barbour & Combe Ltd., Belfast, as engr.; 1893-1904, marine engr. From 1904 to 1925 work included the following; Outside supt., W. B. Brown, I. E. Bankhall, Engrs., Liverpool; drawing office, Lever Bros., Port Sunlight; supt., C. & A. Musker, Engrs., The Brook, Liverpool; Came to British Columbia and engaged in various engrg. projects; Appointed supt. engr., Consolidated Whaling Corpn. & North Pacific Sea Products Co., in charge of 18 steam vessels and 6 stations; 1925, joined Messrs. Yarrows Ltd.; Came to Vancouver; Accepted a position with Hecate Straits Towing Co., and designed and converted a vessel for log carrying, operated fleet of tugs and barges until formation of Pacific Coyle Navigation Co.; Started in business as consltg. engr.; Appointed Surveyor to British Corporation, consltg. engr. (mech'l), to Vancouver Harbour Commission, etc.; at present, consltg. mech'l. engr. and marine surveyor, and surveyor to British Corporation for the Register of Shipping and Aircraft.

References: A. S. Wootton, J. Robertson, E. A. Cleveland, E. A. Wheatley, A. S. Gentles.

MACLENNAN—WILLIAM EWEN, of 430 South Vickers St., Fort William, Ont., Born at Benbecula, Invernesshire, Scotland, May 23rd, 1903; Educ., 1916-18, Inverness Academy. Served two years with Edwards & Co., Edinburgh, surveyors, and 18 mos. with Cyril & Bishop, Engineers, London, England; 1922-23, instr'man. and estimator, highway constrn. in Sask.; 1923-24, levelman on highway location in Ontario; 1924-29, asst. field engr. on paper mill constrn. and power development; With Dept. of Northern Development as follows: 1931-32, engr. in charge of highway location party, and res. engr.; 1934-35, res. engr., Trans-Canada Highway; at present, res. engr., District of Thunder Bay.

References: H. G. O'Leary, P. E. Doncaster, T. S. Armstrong, G. R. Duncan, F. C. Graham.

MALBY—ARTHUR LESLIE, of 313 Maitland Ave., Peterborough, Ont., Born at London, England, Aug. 5th, 1907., Educ., B.Sc. (E.E.), Univ. of Man., 1934; 1934, generator erection, 1934-35, test course, and at present, student engr., industrial control dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

References: B. Ottewell, V. S. Foster, E. R. Shirley, W. M. Cruthers, L. DeW. Magie.

MARCK—JOHN ALPHONSE, of Burlington, Ont., Born at Hamilton, Ont., Oct. 22nd, 1892; Educ., Hamilton Tech. Inst., 1909-11. I.C.S. course in surveying, 1916-17, R.F.C.; 1911-14, transitman, J. J. MacKay, M.E.I.C.; 1914, Nipigon Forest Reserve; 1914-15, dftsman., City Engr's. Dept., Hamilton; 1915-16, transitman, Manitoba Survey of Townships; 1917-19, res. engr., 1,500 ft. dock, San Pedro de Macoris, Santo Domingo; 1919, rly. engr., Barahona Sugar Co., Barahono; 1919 to date, civil engr., Steel Company of Canada, including rly., blast furnace, sheet mill, open hearth, coke oven constrn., 1928-31, plant layout, 1933-34-35, water commissioner, Town of Burlington, filtration plant now under constrn.

References: C. E. Hogarth, J. J. MacKay, E. G. MacKay, R. E. Butt, W. Hollingworth, J. Stodart.

McCUNE—SAMUEL, of 59 Kathleen St., Sudbury, Ont., Born at Belfast, Ireland, Jan. 8th, 1909; Educ., B.Sc. in Civil Engrg., Univ. of Illinois, 1930; 1926 (Mar.-Nov.), field and office work, Kelker, DeLeuw & Co., Chicago; 1927-28, junior engr. (line and grade), Turner Constrn. Co., New York; 1930-32, bridge designer and dftsman., Atchison Topeka and Sante Fe R.R.; 1934 (July-Oct.), survey of and alignment and grade for wooden pipe line, Label Oro Gold Mines Ltd.; Dec. 1934 to date, dftsman., Dept. of Northern Development, Sudbury, Ont.

References: T. S. Armstrong, T. F. Francis, O. L. Flanagan, J. M. Silliman, R. E. Smythe.

OAKES—CECIL HEWITT, of 4583 First Ave. West, Vancouver, B.C., Born at Cleveland, Ohio, Feb. 4th, 1895; Educ., 1910-15, Liverpool Univ., England; R.P.E. of B.C.; 1915-19, engr. officer, R.N.T.S.; 1919-22, engr. officer, Merchant Service; 1922-24, engr. surveyor, National Boiler & General Insurance Co., England; 1924-27, res. engr., Meccano, Ltd., Liverpool, and Paris; 1927-28, system operator, Quebec Terminal, Shaw. Water & Power Co.; 1928-29, res. engr., and 1929-30, works mgr., Canadian Industries Ltd.; at present, engr. surveyor, Boiler Inspection & Insurance Co. of Canada, Vancouver, B.C.
References: C. T. Hamilton, J. P. Mackenzie, P. Sandwell, F. O. Mills, A. S. Wootton.

PATERSON—WALTER HOWARD, of Owen Sound, Ont., Born at Owen Sound, May 23rd, 1909; Educ., B.Sc., Queen's Univ., 1934; Summers: 1930, county surveying (Grey); 1931, operator, H.E.P.C. of Ont.; 1933, production cost reports on city quarry, Owen Sound; 1934 (June-Sept.), res. engr. (grading), concrete pavement, constrn., McArthur Engrg. & Constrn. Co. Ltd.; Sept. 1934 to date, asst. to city engr. Owen Sound, general work, complete charge of waste water survey.
References: F. McArthur, R. C. McKnight, T. D. Kennedy, R. McDowall, W. L. Malcolm.

PIERCE—ARTHUR LEONARD, of Nipigon, Ont., Born at Haileybury, Ont., Aug. 15th, 1908; Educ., B.Sc. (C.E.), Univ. of Man., 1930; 1927-28 (summers), timekpr., chainman and rodman, Dept. of Northern Development; 1929 (Apr.-Oct.), struct'l. dftsman on reinforced concrete constrn., Cowin & Co., Winnipeg; 1930-31, struct'l. dftsman. on reinforced concrete structures, estimating steel and concrete structures, Dominion Bridge Co., Winnipeg; 1931-32, levelman and transitman, Dept. of Northern Development; 1934 (Aug.-Dec.), asst. to engr. on constrn. of water supply and pipe line for Transcona, Man., for Dominion Constrn. Co., Winnipeg, under direction of C.N.R.; 1935 (Jan.-Mar.), res. engr., in charge of highway and bridge constrn., Dept. of Nor. Development; Apr. 1935 to date, office engr. in charge of gen. office and dfting of the Nipigon Div., Dept. of Nor. Development.
References: O. L. Flanagan, T. C. Main, A. E. MacDonald, H. B. Henderson, G. Alison.

RAE—WILLIAM, of Vancouver, B.C., Born at Edinburgh, Scotland, Oct. 17th, 1876; Educ., I.C.S., C.P.R. Mech'l. Exam. for Instructor and Examiner, 1904; 1892-98, ap'tice, mech'l. engr., C.P.R.; 1898-99, engr., C.P.R. SS. Service; 1899-1904, erecting engr., and 1904-05, mech'l. instructor, C.P.R.; 1905-06, mech'l. instructor, I.C.S., Scranton; 1907-09, master mechanic, Kettle Valley Railway; 1910 to date, chief inspector, equipment and appliances, Dept. of Railways, Govt. of British Columbia.
References: E. A. Wheatley, P. H. Buchan, J. Robertson, A. S. Wootton, G. M. Gilbert.

SCALES—WILLIAM, of Courtenay, B.C., Born at Stackallen, Navan, Co. Meath, Ireland, June 5th, 1885, Educ., McGuire's Civil Service College, Dublin, 1901-05. Thomason Civil Engineering College, Rurkee, India, 1908-10. Sub. Engr's. Higher Cert., 1910; 1910-11, asst. to subdivnl. officer, Bombay Subdivn., P.W.D., India; 1910-11, A/Subdivnl. officer, Rajkote, India, roads and bldgs.; 1912-15, subdivnl. officer, Presidency District, Bombay, India. Design and constrnl. of roads, bldgs., water works, sewers, and sea wall; 1915-16, subdivnl. officer, roads and bldgs., Belgaum, India; 1916, services placed at disposal of Commander in Chief in India. In charge of section of Field Park engrg. supplies, Mesopotamia; 1916-17, Garrison Engr., 16th Indian Divn., Waziristan Field Force; 1917-19, Garrison Engr., Jhelum, India; 1919-20, Military Works Services, India, at Bombay, on supervn. of works; 1920-28, consltg. engr. to municipalities St. Lina & Ashmont, Alta., on road diversions, etc.; 1928-31, engrg. asst., city of Calgary; 1931-33, city engr., Fernie, B.C.; 1934 to date, city engr and supt. of public utilities, Courtenay, B.C.
References: E. A. Wheatley, J. Robertson, H. N. Macpherson, G. M. Gilbert, C. T. Hamilton, J. P. Mackenzie, P. Sandwell, F. O. Mills, E. C. Thrupp.

WALKER—ROY EDWARD, of 1034 Aird St., Saskatoon, Sask., Born at Langdon, North Dakota, May 9th, 1907; Educ., B.Eng., Univ. of Sask., 1932. Cert. of Educ., Univ. of Sask., 1935; 1929, apt. block constrn.; 1929-30, elect'l. wiring, apt. blocks and houses; 1930, chaining and dfting., engrg. dept., City of Saskatoon; 1930, rodman, office and field, C.P.R.; 1934, Sask. Highway Dept.; at present, teacher of the Flat Lake S.D. No. 839 (First Class and High School Teacher's Cert.).
References: A. R. Greig, C. J. Mackenzie, I. M. Fraser, W. E. Lovell.

WILLS—DOUGLAS CECIL, of 59 Ontario St. South, St. Catharines, Ont., Born at Bexhill on Sea, Sussex, England, Feb. 17th 1887; Educ., surveying and mapping, London Polytechnic, London, England; 1911-15, with F. N. Rutherford, A.M.E.I.C., O.L.S. and Township Engr., St. Catharines, Ont. Field work: in charge of small parties on land surveys, sub-divisions, road constrn., tunnelling. Office: plotting, maps from field notes, making and tracing maps, computations, etc.; 1915-19, overseas, C.E.F. and B.E.F. 1917-19, service in France as engrg. officer to company of Can. Rly. Troops on track repair and constrn., roads, bridges, demolitions; 1919-33, instr'man and junior engr., and 1933 to date, instr'man and field engr. (office and field work). Dept. of Railways and Canals, Welland Canals, St. Catharines, Ont.
References: C. G. Moon, C. W. West, E. G. Cameron, M. B. Atkinson, J. C. Moyer, A. L. McPhail, L. P. Rundle.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BALL—ALFRED N., of Ottawa, Ont., Born at Grenfell, Sask., Dec. 1st, 1889; Educ., B.Sc., Queen's Univ., 1914; D.L.S., S.L.S.; 1912 (summer), location surveys, G.T.P. in Sask.; 1913-15 (summers), instr'man. on surveys for Sask. Govt.; 1915-19, overseas; 1919-21, surveyor, Parsons Engrg. Co., Regina; 1921-23, res. on bridge and road constrn. for Sask. Govt.; 1923-25, designing engr., Can. Sugar Ref. Co., Montreal; 1925-26, designing engr., Riordon Pulp Corpn.; 1926-28, designing engr., St. Lawrence Paper Mills Ltd.; 1928-29, res. engr. i/c constrn. and equipment installn. of timber limit development at Trinity Bay, Que., for St. Lawrence Paper Co.; 1929-30, res. engr. i/c constrn. and equipment installn. at Campbellton, N.B., for Restigouche Co. Ltd. (sulphite mill); 1930-35, on gen. design, filtration plant and sulphite mill, etc., and at present, chief engr., i/c design and constrn. of gen. mill revisions and extensions, E. B. Eddy Co. Ltd., Hull, Que. (*A.M. 1919.*)
References: W. S. Kidd, H. Kennedy, F. O. White, A. P. Linton, D. A. R. McCannel.

BELL-IRVING, ROBERT, of Vancouver, B.C., Born at Vancouver, July 30th, 1893; Educ., B.Sc., McGill Univ., 1914; B.C.L.S.; 1912-13-14 (summers), irrigation constrn. work, Taylor & Bell-Irving, Engrs. and Land Surveyors; 1914-18, overseas, Capt., Royal Engrs.; 1920, partner, Fullerton & Bell-Irving, Engrs. and Surveyors; 1921 to date, with Powell River Co. Ltd., as follows: 1921, field engr., 1921-26, senior engr., full charge of design and constrn., and carried out paper mill and power plant developments; 1926-32, res. mgr., at Powell River, B.C., in charge of operations, continuing to act in advisory capacity to engrg. dept.; At present asst. gen. mgr., of company, at Vancouver, B.C. (*A.M. 1920.*)
References: W. G. Swan, A. S. Gentles, J. Robertson, E. A. Wheatley, E. A. Cleveland.

JARMAN—PERCY EDWARD, of Westmount, Que., Born at Earls Colne, Essex, England, Jan. 6th, 1885; Educ., private tuition; 1904-06, inspr. of struct'l. steel work, Dominion Bridge Co.; 1906-08, asst. town engr., Town of Outremont, Que.; 1908-10, asst. engr., 1910-13, asst. city engr., 1913-30, city engr., and 1930 to date, general manager, City of Westmount, Que. (*St. 1909, Jr. 1914, A.M. 1917.*)
References: E. A. Ryan, K. B. Thornton, P. L. Pratley, G. E. Templeman, J. L. Busfield.

MACKENZIE—JOHN PERCIVAL, of Vancouver, B.C., Born at Boissevain, Man., May 8th, 1884; Educ., three years civil engrg., Univ. of Glasgow; 1904-07, Toronto Street Railway, Can. Nor. Rly.; 1907-12, constrn. engr., Can. Nor. Rly.; 1912-14, asst. engr., Dept. Public Works, La Pointe Pier; 1914-19, overseas, Lt.-Col., D.S.O., 2 Bars, C. de G.; 1919-20, supt., Pacific Atlantic Construction; 1920-23, chief engr., Henry & McFee, Seattle, Wash.; 1923-25, gen. supt. and chief engr. for same company, constrn. Natron cut-off for Southern Pacific Rly. Co.; 1925-27, gen. supt. for same company, constrn., fitting out pier for Bremerton Navy Yard; 1927-28, field engr., St. John Dry Dock and Shipbldg. Co., St. John, N.B.; 1929-32, gen. sales mgr., and 1932 to date, gen. manager, Western Bridge Co., Vancouver, B.C. (*A.M. 1920.*)
References: J. Robertson, A. S. Wootton, H. N. Macpherson, P. H. Buchan, E. A. Wheatley.

McKENZIE—JAMES EDGAR, of 239-12th Ave. West, Calgary, Alta., Born at Calgary, June 29th, 1889; Educ., B.Sc., Queen's Univ., 1912; 1911-12, with J. C. Teague, Architect, Calgary, struct'l. steel and concrete design; 1912-13, Stanton & McKenzie, Struct'l. Engrs.; 1913-17, president and chief engr., Thomas-Jamieson-McKenzie Ltd., General Contractors, bldg. and gen. constrn. work in Alberta; 1917-21, J. E. McKenzie Ltd., General Contractors and Engineers, Calgary; 1922-32, chief engr. and estimator for E. J. Ryan Contracting Co. Ltd., Vancouver. Designing principally reinforced concrete, water tower, sewer and water works. Superintendence and estimating. (*St. 1912, A.M. 1918.*)
References: R. S. Trowsdale, P. M. Sauder, P. H. Buchan, E. A. Wheatley, A. S. Gentles.

PENFOLD—DOUGLAS KENT, of Kelowna, B.C., Born at Maidstone, England, Dec. 22nd, 1888; Educ., 1907-11, Bengal Engrg. College, Calcutta, Diploma in Mining; Colliery Manager's Certs., 2nd Class 1915, 1st Class 1916; 1911-12, asst. mgr., Bhaga Colliery Co. Ltd.; 1912-13, asst. mgr., Indian Oil Products Ltd.; 1913-16, asst. mgr., East Indian Coal Co. Ltd., 1916-18, asst. mgr., later mgr., Bengal Coal Co. Ltd.; 1918-19, mgr., Tata Iron and Steel Co. Ltd., 1919-22, mgr., East Nandi Coal Co. Ltd.; 1925-26, field engr., B.C. Electric Rly. Co. Ltd., Vancouver; With the Govt. of British Columbia as follows: 1927-30, office engr., Water Rights Br., Victoria, and 1930 to date, district engr., Water Rights Branch, Kelowna, B.C. (*A.M. 1929.*)
References: E. Davis, F. W. Knewstubb, J. C. MacDonald, E. A. Wheatley.

SANDWELL—PERCY, of Vancouver, B.C., Born at London, England, Nov. 7th, 1888; Educ, Technical Schools, London, England; 1904-09, ap'ticeship, Geo. Aston & Sons, London, mech'l. and struct'l. engrg.; 1909-11, engr., Hales Ltd., London, mtce. and management of steam haulage plant; 1911-13, chief mech'l. dftsman., Shepherds Bush Exhibition Ltd., London; 1913-14, engr. in charge, works dept., Gillman & Spencer Ltd., millers and feed mfgrs., London; 1914-20, war service in France, R.F.A. Lieut., R.E., Staff Officer, C.R.E.; 1920-22, engr. and dftsman., and 1922-26, chief dftsman. and asst. res. engr., Powell River Co. Ltd.; 1926-32, res. engr., and 1932-34, asst. mgr. of same company, at Powell River, B.C.; At present, consltg. mech'l. engr., Vancouver, B.C. (*A.M. 1923.*)
References: J. Robertson, E. A. Wheatley, A. S. Gentles, R. Bell-Irving, P. H. Buchan, J. P. Mackenzie.

TAUNTON—ARTHUR JOHN SHOWELL, of 930 Somerset Ave., Winnipeg, Man., Born at Solihull, Warwickshire, England, Aug. 17th, 1888; Educ., B.Sc. (C.E.), Univ. of Man., 1912; 1904-06, engrg. pupil, Kynoch's Ltd., Birmingham; 1907-08 and summer 1909, instr'man., dftsman., inspr., Winnipeg hydro development; Summers 1910-11, and 1912-13, asst. engr., bridge engr's. dept., Can. Nor. Rly.; 1913-14, and 1919-20, asst. engr. in same dept., in responsible charge of constrn. of all bridges on the Brazeau extension, Alta., and permanent steel bridges at Kaministiquia River, Bears Pass, etc.; 1914-19, overseas, Major, D.S.O.; 1920-30, district bridge engr., Manitoba Prov. Govt., in charge of design, constrn. and acting. for highway structures; 1930-33, Member of Board of Engineers, and engr. in charge of constrn. of Norwood, Main St. and Salter St. bridges; At present, temp. senior asst. engr., Dept. Public Works, Canada, in charge of design and constrn. of Selkirk bridge, Winnipeg, Man. (*St. 1909, A.M. 1914.*)
References: F. G. Goodspeed, W. P. Brereton, E. V. Caton, W. Walkden, E. P. Fetherstonhaugh.

TRIPP—GEORGE MASON, of 1684 Yale St., Oak Bay, Victoria, B.C., Born at Woodstock, Ont., Nov. 14th, 1875; R.P.E. of B.C.; 1898-1903, gen. elect'l. engrg. work, and 1903 to date, gen. supt., B.C. Electric Rly. Co. Ltd., Vancouver Island Divn., in charge of engrg. dept. (*A.M. 1919.*)
References: E. E. Carpenter, H. L. Swan, J. C. MacDonald, A. C. Eddy, E. Davis.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BRAIN—CECIL, of Corner Brook, Nfld., Born at Sittingbourne, Kent, England, Sept. 6th, 1901; Educ., B.Sc., McGill Univ., 1928; 1924-25-26 (summers), carpenter, millwright, mechanic, Anglo-Nfld. Development Co., Grand Falls, Nfld.; 1927 (summer), fitter, Charles Walmsley & Co., Longueuil, Que.; 1928-30, dftsman., 1930 to date, asst. to plant engr., in charge of mtce. planning and cost dept., belting and all physical records, International Power and Paper Co. of Nfld., Corner Brook, Nfld. (*St. 1927, Jr. 1929.*)
References: K. O. Elderkin, R. L. Weldon, H. C. Brown, H. S. Windeler, C. M. McKergow.

BURGESS—BERT. I., of 595 King St., Peterborough, Ont., Born at Fairville, N.B., July 18th, 1898; Educ., B.Sc., Univ. of N.B., 1921; 1922-26, and 1929 to date, switchboard engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*Jr. 1924.*)
References: E. R. Shirley, T. E. Gilchrist, B. Ottewell, A. L. Dickieson, A. B. Gates.

FANJOY—WILLIAM THOMAS, of 223 Crescent St., Peterborough, Ont., Born at Sherbrooke, Que., Jan. 3rd, 1902; Educ., B.Sc., Univ. of Alta., 1924; 1924 (6 mos.), elect'l. constrn., Can. Westinghouse Co.; 1925-26, test dept., and 1926 to date, industrial control engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1925, Jr. 1929.*)
References: W. E. Ross, R. L. Dobbin, L. DeW. Magie, E. R. Shirley, J. W. Pierce, H. J. MacLeod.

HAYES—ST. CLAIR JOSEPH, of St. John's, Nfld., Born at Halifax, N.S., Dec. 24th, 1899; Educ., B.Sc. (E.E.), 1922, B.Sc. (M.E.), 1923, N.S. Tech. Coll.; 1919 (summer), machine shop ap'tice, Burns & Keilher, Halifax; 1920, asst. in power house inventory, Jackson & Moreland, Boston, Mass.; 1923-33, Can. Gen. Elec. Co. Ltd., Peterborough; 1½ years test course; 1924-30, D.C. engrg. dept., estimating, proposition work and designing; 1930-33, acting renewal parts engr.; 1934-35, asst. prof. of engrg., St. Mary's College, Halifax; At present, lecturer in engrg., in charge of engrg. dept., Memorial University College, St. John's, Nfld. (*St. 1923, Jr. 1926.*)
References: L. DeW. Magie, W. M. Cruthers, A. B. Gates, B. Ottewell, F. R. Faulkner, G. H. Burchill, R. L. Dobbin.

SILLS—HUBERT RYERSON, of 513 Gilmour St., Peterborough, Ont., Born at Kingston, Ont., Sept. 19th, 1900; Educ., B.Sc., Queen's Univ., 1921; 1916-17, lathe hand, shell shop; 1918-19, instr'man., Geol. Survey; 1920, assembly work, transformer shop; 1921-22, test course, and 1922 to date, synchronous motor and A.C. generator design work as asst. engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1921, Jr. 1926.*)
References: B. L. Barns, L. DeW. Magie, R. L. Dobbin, E. R. Shirley, V. S. Foster.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situation Vacant

SUPERINTENDENT, for radio manufacturing plant. Mechanical or radio engineer who has had several years successful experience in organization and operating factories on mass production principles. In replying give full information as to training and experience. Apply to Box No. 1233-V.

Situations Wanted

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

MECHANICAL ENGINEER, experienced in mechanical and structural design, and plant maintenance. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

Situations Wanted

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

Situations Wanted

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E..Q, married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

Situations Wanted

CHEMICAL ENGINEER, B.sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.sc. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, JR.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mach. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.sc. '32, M.sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, JR.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, A.M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

Symposium on Welding

A symposium on the welding of iron and steel organised by the Iron and Steel Institute, London, England, in cooperation with fifteen other institutions and technical societies was held in London in May, 1935. One hundred and fifty papers were presented, and over one thousand persons were present at some of the sessions.

The bound volumes containing a full account of the proceedings were published in November, and take the form of two volumes containing respectively seven hundred and one thousand pages of print and a large number of illustrations, they include technical papers written for the symposium by leading experts and discussions of the papers and authors' replies.

The Organizing Committee has kindly offered to make the volumes available to members of The Engineering Institute at a specially reduced price of £1 12s. per set, carriage paid. To obtain this reduction from the standard rate of £2 4s. orders should be placed through The Engineering Institute.

Canada and U.S.A.

In connection with the negotiations which have been taking place for a commercial agreement between the United States and Canada, some interesting data have been made public regarding the balance of payments between the two countries in recent years.

According to a statement submitted to Washington by Ottawa, in no years since 1882 have Canadian exports to the United States exceeded in value the Dominion's imports from the United States. During the thirty years ending in 1933, Canada purchased in the United States almost 70 per cent of all her imports and sold in the United States only 37 per cent of all her exports. In the last ten years Canadians have spent over $1.60 in buying products of the United States for every dollar spent on Canadian products by purchasers in the United States, and Canada therefore has been obliged to meet the resulting debit balance by other means of payment. In the first nine months of 1934, again, Canadian imports from the United States increased more rapidly than Canadian exports to the United States, and the ratio between them is now stated at 10 to 7.

—The Times Trade and Engineering.

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